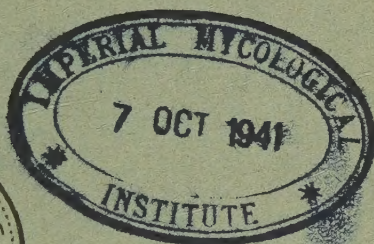


THE
Tea Research Institute
OF
Ceylon.

BULLETIN No. 22

Annual Report for the Year
1940.



Published by
THE TEA RESEARCH INSTITUTE OF CEYLON,
ST. COOMBS, TALAWAKELLE.

The Tea Research Institute of Ceylon.

SCIENTIFIC STAFF.

Director ... Roland V. Norris, D.Sc. (Lond.),
M.Sc. (Manc.), F.I.C.

Department of Mycology.

Mycologist ... C. H. Gadd, D.Sc. (Birm.)
Assistant Mycologist ... T. E. T. Bond, Ph.D. (Cantab), M.Sc.
Assistant ... C. A. Loos. (Reading).

Department of Agricultural Chemistry.

Agricultural Chemist ... T. Eden, D.Sc. (Manc.), A.I.C.
Research Assistant ... J. G. Shrikhande, Ph.D. (Lond.)
M.Sc. (Nagpur), A.I.C.
Assistant ... E. N. Perera
Field Assistants ... M. Piyasena
... B. T. Schuiling

Department of Biochemistry.

Biochemist ... J. Lamb, M.Sc. (Lond.) A.I.C., A.I.C.T.A
Research Assistant ... H. B. Sreerangachar, M.Sc. (Bombay),
B.Sc. (Mysore), A.I.C., A.I.I.Sc.
Assistants ... V. Mendis
... E. L. Keegel
... P. R. Perera

Department of Entomology.

Entomologist ... C. B. Redman King, M.A. (Cantab.), M.C.
Assistant Entomologist ... G. D. Austin [on military service]
Assistant ... D. J. William
Field Assistant ... W. T. Fonseka

Department of Plant Physiology.

Plant Physiologist ... F. R. Tubbs, Ph.D. (Lond.), D.I.C., A.R.C.S.,
F.L.S. [on military service]
Assistant ... M. H. E. Koch
Field Assistants ... F. H. Kehl
... F. P. Jayawardana

Small-Holdings Officers.

... R. L. Illankoon
... F. D. Tillekeratne

Superintendent, St. Coombs Estate ... J. A. Rogers

NOTE.

The Laboratories of the Institute are situated at St. Coombs Estate Talawakelle, and letters and enquiries should be addressed to the Director Tea Research Institute of Ceylon, St. Coombs, Talawakelle. Telegraphic Address:—Research, Talawakelle; Telephone, Talawakelle 44 (Private Exchange). It is particularly requested that letters should not be addressed to officers by name.

FIFTEENTH ANNUAL REPORT

OF THE

BOARD OF THE TEA RESEARCH

INSTITUTE OF CEYLON

FOR 1940.

Foundation.—The Tea Research Institute of Ceylon was established by Ordinance No. 12 of 1925, dated the 27th October, 1925.

Past Chairmen of the Institute.

Name	Date of Assuming Office	Date of Resignation
Major J. W. Oldfield, C.M.G., O.B.E., M.C.	7th January, 1926.	24th November, 1926.
Mr. John Horsfall	24th November, 1926. (Acting)	14th April, 1927.
Mr. R. G. Coombe	15th April, 1927.	9th April, 1929. (leave)
Major J. W. Oldfield, C.M.G., O.B.E., M.C.	10th April, 1929. (Acting)	30th September, 1929.
Mr. C. H. Wilkinson	1st October, 1929. (Acting)	28th November, 1929.
Mr. R. G. Coombe	20th November, 1929.	7th April, 1932. (leave)
Mr. G. K. Stewart	8th April, 1932. (Acting)	26th November, 1932.
Mr. R. G. Coombe	27th November, 1932.	13th January, 1934.
Mr. James Forbes	14th January, 1934.	31st October, 1936. (leave)
Mr. R. G. Coombe	1st November, 1936. (Acting)	2nd June, 1937.
Mr. James Forbes	3rd June, 1937.	31st December, 1940.
Mr. T. B. Panabokke, Adigar.	1st January, 1941.	

BOARD OF MANAGEMENT.

The Constitution of the Board is laid down in the Ordinance; the personnel on the 1st day of January, 1940, was :—

Ex-Officio Members.

The Hon'ble the Financial Secretary (Hon'ble Mr. H. J. Huxham).
 The Director of Agriculture (Mr. E. Rodrigo, C.C.S.)
 The Chairman, Planters' Association of Ceylon (Mr. R. C. Scott).
 The Chairman, Ceylon Estates Proprietary Association (Mr. C. H. Bois).

Representatives of the Planters' Association of Ceylon.

Mr. James Forbes (Chairman).
 Mr. R. G. Coombe.
 Mr. J. D. Hoare (on leave), Mr. R. Gregor (Acting).

Representatives of the Ceylon Estates Proprietary Association.

Major J. W. Oldfield, C.M.G., O.B.E., M.C.
 Mr. I. L. Cameron.
 Mr. J. C. Kelly.

Representative of the Low-Country Products Association.

Mr. S. F. H. Perera.

Representative of the Small-Holders.

Mr. T. B. Panabokke, Adigar.

Chairman.—Mr. James Forbes.

Secretary.—Dr. Roland V. Norris.

Solicitors.—Messrs. Julius & Creasy.

Auditors.—Messrs. Ford, Rhodes, Thornton & Co.

Registered Office.—The Victoria Commemoration Building, Kandy.

The Chairman T.R.I.—Mr. James Forbes was the Chairman of the Board throughout the year but resigned as from 31st December, preparatory to going on home leave. Mr. Forbes, who has been a Member of the Board since 1930, has served as Chairman since January, 1934, and the Board in accepting his resignation with much regret recorded in the Minutes their great appreciation of the very valuable services rendered to the Institute by Mr. Forbes during his term of office.

Mr. T. B. Panabokke, who was one of the original Members of the Board, has accepted the invitation of the Board to assume the Chairmanship as from the 1st January, 1941. In accepting office, he expressed the hope that some other Member of Board will relieve him after a short term.

Membership of the Board.—Mr. W. H. Gourlay was nominated by the Ceylon Estates Proprietary Association to act for Mr. I. L. Cameron during the absence of the latter gentleman on leave.

Mr. J. D. Hoare resumed his place on the Board in December on his return from leave, replacing Mr. R. Gregor who had acted for him with much acceptance. The thanks of the Board are due to Mr. Gregor for his services.

Meetings of the Board.—Four meetings of the Board were held during the year, all in Colombo. The average attendance was 10.

Auditors.—Messrs. Ford, Rhodes, Thornton & Co. continued to act as the Institute's Auditors.

COMMITTEES.

Finance Committee.—The Chairman, T.R.I.; the Chairman, Planters' Association of Ceylon; the Chairman, Ceylon Estates Proprietary Association; Major J. W. Oldfield, C.M.G., O.B.E., M.C.; Mr. J. D. Hoare (on leave), Mr. J. C. Kelly and the Director, T.R.I.

Mr. R. Gregor acted throughout the year for Mr. J. D. Hoare during the latter's absence on leave.

This Committee held three meetings during the year.

Estate and Experimental Sub-Committee.—The Director, T.R.I. (Chairman); the Chairman, T.R.I.; the Visiting Agent (Mr. H. Tonks); the Superintendent, St. Coombs; Messrs. R. G. Coombe, D. T. Richards, R. H. Horne, J. T. Young, F. J. Whitehead, G. K. Newton and Dr. T. Eden (Secretary).

Mr. F. A. Bond acted on this Committee during the absence on leave of Mr. D. T. Richards and Mr. W. J. Craig acted in a similar capacity for Mr. J. T. Young.

The Committee held three meetings during the year.

Medical Scheme Sub-Committee.—The Chairman, T.R.I.; the Director, T.R.I., and Mr. G. D. Austin (representing the Junior Staff).

Trustees of the Junior Staff Provident Fund.—The Chairman, T.R.I.; the Director, T.R.I.; Mr. R. G. Coombe and Mr. E. N. Perera (representing the Junior Staff).

Visiting Agent.—Mr. H. Tonks continued to act as Visiting Agent and paid three visits of inspection to St. Coombs during the year. The thanks of the Board are due to him for his valuable advice.

FINANCE.

The total receipts for the year amounted to Rs. 395,612 made up as follows : Cess Rs. 344,505, Profit on St. Coombs Estate Working Account Rs. 46,507 and Interest and Miscellaneous Receipts Rs. 4,599. Receipts were thus Rs. 35,567 higher than in 1939, due to much higher exports of tea reflected in an increased cess, and higher estate profits.

Expenditure on Revenue Account, including Research Revenue Expenditure at Rs. 233,969, Depreciation at Rs. 42,088, Interest charges on the Government Loan at Rs. 39,234, and Expenditure on the Food Production Scheme of Rs. 536, amounted to Rs. 315,627, as against Rs. 313,995 in 1939. There was thus a Surplus on Revenue Account of Rs. 79,814. the corresponding figure in 1939 being Rs. 45,640. Capital expenditure was incurred to the extent of Rs. 54,001, this sum comprising expenditure on assets of Rs. 18,409 and Rs. 35,592 representing repayment of the Government Loan.

Liquid assets as at 31st December, 1940, after providing for specific liabilities, such as accrued interest on the Government Loan and Furlough and Passages Reserves, amounted to Rs. 282,777 equivalent to 70.8 per cent. of the liability under the Depreciation Reserve which at the same date amounted to Rs. 399,362.

ST. COOMBS ESTATE.

Weather conditions were very unfavourable in the first three months of the year when severe drought conditions prevailed resulting in very low cropping. Exceptionally heavy rain fell in May, a fall of 17 inches occurring in two days. Subsequently, however, rainfall was below average but well distributed with the result that good cropping conditions prevailed in the second half of the year. Crop at 175,270 pounds, while short of the estimate (185,000 pounds), was 23,341 pounds above that for 1939.

131,977 pounds of made tea were supplied to the Ministry of Food under 1940 Contracts Nos. 1 and 2, at an average price of 83.25 cents per pound, and 42,391 pounds were sold on the Colombo market at an average price of Rs. 1.01 per pound. The average price obtained for the whole crop was 87.62 cents gross and 84.74 cents nett, the respective figures for 1939 being 84.74 and 79.74 cents.

The higher prices obtained more than offset the shortfall in crop and the profit on Estate Working Account at Rs. 46,507 representing Rs. 176 per acre, was the highest yet realised on St. Coombs.

Favourable inspection reports were received on the Estate School and a grant of Rs. 263 was received from Government.

PUBLICATIONS.

The Institute's publications are sent free of charge to Proprietors, Directors, Superintendents and Assistant Superintendents of all Ceylon Tea Estates of over 10 acres in extent and to London and Colombo Agency Firms dealing with tea if they register their names with the Secretary.

Other persons can obtain the publications on payment of an annual subscription of Rs. 15 per annum if resident in India or Ceylon or £15.0 if resident elsewhere. Single numbers of *The Tea Quarterly* or Bulletins can be obtained at Rs. 2-50 or 4 shillings per copy.

There is a wide demand for these publications and a sum of Rs. 4,937 was received in subscriptions. Rs. 2,932 was also received for advertisements, as a result of which there was a profit on publications of Rs. 2,410.

The following publications were issued during the year :—

The Tea Quarterly, Vol. XIII, Parts I-IV.

Bulletin No. 20, General Index to Institute's Publications 1926-1938.

Bulletin No. 21, Annual Report for 1939,

The General Index issued in Bulletin No. 20 has met a longfelt want.

This will be brought up to date at regular intervals.

ACKNOWLEDGMENTS.

As usual close co-operation has been maintained with the Ceylon Association in London, the Planters' Association of Ceylon, the Ceylon Estates Proprietary Association, and other bodies concerned in the Tea Industry and the thanks of the Board are due to these Associations for their continued interest and assistance in the working of the Institute.

Thanks are due to the Ceylon Chamber of Commerce, Colombo, for the use of their Committee Room for meetings of the Board held in Colombo.

The Audited Statement of Accounts and Balance Sheet for 1940 are attached, together with the reports of the Visiting Agent and of the Director and Scientific Staff dealing with the research activities of the Institute.

ROLAND V. NORRIS.

Secretary

THE TEA RESEARCH INSTITUTE OF CEYLON.

BALANCE SHEET AS AT 31st DECEMBER, 1940.

LIABILITIES		ASSETS	
	Rs. Cts.		Rs. Cts.
CREDITORS & CREDIT BALANCES :—		DEBTORS & DEBIT BALANCES :—	
Accrued Interest on Loan	9,441-57	Principal Collector of Customs (Since Received)	30,295-03
Sundry Creditors—Research	2,550-75	Interest on £ 2,300, 3½ % War Loan £ 40-5-0	532-97
Sundry Creditors—Estate	7,030-89	G. E. Stechert. Sub. for Pub. 1940] £1-5-0	16-50
Subscriptions for Publications received in advance	39-01	Whittall & Co., being commission on shipment of produce to London, £1-10-6	20-33
		Gordon Frazer & Co., Sub. for Pub. 1940. a/c. A. W. Harrison	16-66
		Refund, being excess payment on Passage a/c Dr. and Mrs. R. V. Norris	484-00
			<u>31,365-49</u>
FURLOUGH RESERVE :—		SUNDRIES RESEARCH :—	
At 31st December, 1939	3,421-29	Ceylon Association in London £ 19-17-11	Rs. Cts. 265-27
Additions during 1940	9,619-00	Research Staff	1,653-54
	13,040-29	Sundry Debtors	893-00
<i>Deduct : Payments during 1940</i>	6,835-11	a/c Advertising	869-02
		Accrued Interest on Fixed Deposits	3,680-83
			<u>5,813-34</u>
DEPRECIATION RESERVE :—		SUNDRIES—ESTATE	
At 31st December, 1939	358,183-49		37,208-83
Credited at 31st December, 1940	42,087-69	STOCK-IN-HAND	
	400,271-18	Tea 43,359 lbs.	39,259-51
<i>Less: Items written off in 1940</i>	909-19	Estate Rice	1,855-70
		Stock A/c.	3,196-99
			<u>44,312-20</u>
		INVESTMENTS	
		£ 2,300 0-0, 3½ % War Loan	32,434-76
		£ 2,063-18-1, 4 % Funding Loan 1960/90	29,928-06
		Rs. 30,000/- 3½ % Ceylon Govt. Loan 1957/62	29,512-50
			<u>Carried over</u>
			Rs. 173,396-35
Carried over	Rs. 424,629-39		

THE TEA RESEARCH INSTITUTE OF CEYLON.

BALANCE SHEET AS AT 31st DECEMBER, 1940.

LIABILITIES

	Rs.	Cts.
Brought forward	424,629	39

ASSETS

	Rs.	Cts.	Rs.	Cts.
CASH :—				
Fixed Deposit	...	...	80,131	05
Current Account	...	...	55,541	78
Petty Cash Account	...	...	347	64
			136,020	47
Estate—N.B.I. Colombo	...	651	39	
" In Hand	...	18	47	
			669	86
FUNDS OVERSPENT To				
31st December, 1940	...	...	140,355	76
Capital Expenditure 1940	...	...	18,409	38
Repayment of Govt. Loan 1940	...	...	35,591	88
			194,357	02
Less : Revenue applied for				
Capital purposes, being Revenue				
Account Surplus for the year 1940			79,814	31
			114,542	71

Rs. 424,629 39

Rs. 424,629 39

We have audited the books of the Tea Research Institute of Ceylon and have obtained all the information and explanations required by us.

The allocations of Capital Expenditure and of Research Revenue Expenditure as made by the Director have been accepted by us.

We are not in a position to say whether the Reserves made for Depreciation are adequate.

Subject to the foregoing reservations, the above Balance Sheet, in our opinion, is properly drawn up so as to exhibit a true and correct view of the financial affairs of the Institute at 31st December, 1940, according to the best of our information and the explanations given to us, and as shown by the books.

(Sgd.) FORD, RHODES, THORNTON & CO.

Chartered Accountants.

Colombo, 17th March, 1941.

THE TEA RESEARCH INSTITUTE OF CEYLON.

Dr.	CAPITAL ACCOUNT AS AT 31st DECEMBER, 1940.				Cr.	
	EXPENDITURE		RECEIPTS			
	To 31-12-39 Rs. Cts.	Additions in 1940 Rs. Cts.	Deduct cost of Assets sold or scrapped in 1940 Rs. Cts.	Total Rs. Cts.	Rs.	Rs. Cts.
To LAND INCLUDING DEVELOPMENT	841,722-32	10,093-93	—	851,816-25	BY GOVERNMENT OF CEYLON:— Loan on Mortgage at 5½ % per annum 1,000,000.00	
" BUILDINGS AND LINES	904,700-66	8,795-16	—	913,495-82	Rs. Cts.	
" FURNITURE AND EQUIPMENT	81,441-95	11-00	415-50	81,037-45	Less: Repayments to 31-12-39 277,748-26 Payments 1940 35,591-88	
" LABORATORY AND EQUIPMENT	41,971-39	843-48	193-69	42,621-18	REVENUE APPLIED FOR CAPITAL PURPOSES TO 31-12-39 1,177,414-60	
" EXPERIMENTAL MACHINERY	29,705-38	—	—	29,705-38	Do Do 1940 79,814-31 1,257,228-91	
" MACHINERY ESTATE	129,069-37	75-00	800-00	128,344-37	FUNDS OVERSPENT TO 31-12-39 140,355-76	
" MOTOR CAR	4,025-00	—	—	4,025-00	Less: 1940 UNDERSPENT 25,813-05 114,542-71	
" MOTOR ROAD ROLLER	7,386-03	—	—	7,386-03		
	Rs. 2,040,022-10	19,818-57	1,409-19	2,058,431-48	Rs. 2,058,431-48	

(Sgd.) ROLAND V. NORRIS,
Director.

St. Coombs
March 18, 1941

THE TEA RESEARCH INSTITUTE OF CEYLON.

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Dr.	LOAN ACCOUNT		Cr.	
	Rs.	Cts.	Rs.	Cts.
To GOVERNMENT OF CEYLON	Rs. 1,000,000-00			
	By REPAYMENTS PRINCIPAL:—			
	1st Instalments 1929	18,227-00		
	2nd do 1930	19,320-72		
	3rd do 1931	20,479-00		
	4th do 1932	21,708-60		
	5th do 1933	23,011-09		
	6th do 1934	24,391-74		
	7th do 1935	25,855-23		
	8th do 1936	28,730-36		
	9th do 1937	30,310-53		
	10th do 1938	31,977-61		
	11th do 1939	33,736-38		
	12th do 1940	35,591-88		
	Balance ...	...	313,340-14	
			686,659-86	
				Rs. 1,000,000-00

St. Coombs,
March 18, 1941

(Sgd.) ROLAND V. NORRIS
Director.

THE TEA RESEARCH INSTITUTE OF CEYLON.

ESTATE WORKING ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1940.

EXPENDITURE		INCOME	
To	Rs. Cts.	By	Rs. Cts.
ESTATE EXPENDITURE PREVIOUSLY	94,841.36	TEA SALES—COLOMBO TEA COMMISSIONER, AND BACTERIA CONTROL EXPERIMENT	174,388 lbs. 152,797.38
do do DECEMBER	9,237.55	TEA SALES—LOCAL	640 430.14
CHARGES—EXPORT DUTY, ETC.	3,860.85	Do —BIOCHEMICAL DEPT.	242 143.68
BALANCE CARRIED FORWARD	46,507.12	Do —BROKEN MIXED	2,338 353.20
		MOTOR ROAD ROLLER ACCOUNT	722.48
			<u>Rs. 154,446.88</u>

Dr.	Rs. Cts.	Cr.	Rs. Cts.
REVENUE ACCOUNT AS AT 31st DECEMBER, 1940.			

To ADMINISTRATION OF THE BOARD :—		By BALANCE FROM ESTATE WORKING ACCOUNT	
Planters' Association of Ceylon	240.00	TEA CESS	46,507.12
Travelling of the Board	1,212.46	INTEREST	344,505.37
Clerical Staff	6,050.00	RENT OF CADDY	4,312.60
Telephone Operators	960.00	MISCELLANEOUS RECEIPTS	60.00
Office Peon	600.00	GUEST HOUSE ACCOUNT	103.88
Postages	466.43		122.55
Stationery	1,081.50		
Advertising	10.00		
Telegrams, Trunk Call etc.	245.67		
Printing	102.00		
Auditors' Fees	765.45		
Contingencies	173.13		
Carried over	Rs. 11,916.64	Carried over	Rs. 395,611.52

THE TEA RESEARCH INSTITUTE OF CEYLON.

REVENUE ACCOUNT AS AT 31st DECEMBER, 1940.—(Contd.)

	Rs. Cts.	Rs. Cts.	Rs. Cts.
TO PERSONAL EMOLUMENTS OF SCIENTIFIC STAFF :—			
Director	22,500-00		
Mycologist	21,193-55		
Agricultural Chemist	18,000-00		
Entomologist	17,831-41		
Plant Physiologist	8,809-04		
Biochemist	12,531-03		
Asst. Mycologist	8,319-33	109,254-36	
EMOLUMENTS OF JUNIOR AND SUB-SCIENTIFIC STAFF :—			
Junior Scientific Staff	37,884-97		
Labour Assistants and Fieldman	4,571-35	42,456-32	
LABORATORY :—			
Equipment and General Working Expenses	5,169-10		
Special Provision for Joint Research on Chemistry of Tea	2,516-26		
Furniture and Office Equipment	8-60	7,693-96	
LIBRARY AND PUBLICATIONS :—			
Library	2,062-90		
Publications	Cr., 2,411-07	Cr. 348-17	
Carried over	Rs. 170,973-11		
		Carried over	Rs. 395,611-52

THE TEA RESEARCH INSTITUTE OF CEYLON.

BULLETIN No. 22.

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REVENUE ACCOUNT AS AT 31st DECEMBER, 1934.—(Contd.)

	Rs. Cts.	Rs. Cts.	Rs. Cts.
To GENERAL SERVICES :—			
Electric Power	...	4,140 00	
Mechanic	...	775 75	
Telephones Rent and Maintenance	...	543 50	
Roads	...	100 00	
Sanitation	...	834 20	
Water Supply	...	952 55	
Tappal Lorry and Book Fees	...	264 00	
Nettikans and Drains	...	75 93	
Upkeep of Grounds	...	760 18	
Guest House	...	562 77	9,008 88
“ MISCELLANEOUS :—			
Incidentals	...	149 76	
Ceylon Planters' Provident Society	...	11,524 36	
Provident Fund, Junior Scientific Staff	...	4,529 06	
Provident Fund, Subordinate Staff	...	1,380 79	
Passages	...	6,000 00	
Ceylon Nursing Assn. and Fraser Nursing Home	...	180 00	
Medical Fees, Subordinate Staff	...	218 87	
Medical Fees, Junior Staff	...	1,296 00	
Insurances	...	2,794 10	
Watchmen and Caretakers	...	345 73	
Conference Expenses	...	186 65	
Rentals	...	626 21	29,231 53
“ FOOD PRODUCTION SCHEME			
“ GOVERNMENT OF CEYLON LOAN	...	536 10	
“ INTEREST ACCOUNT	...	39,234 39	
“ DEPRECIATION	...	42,087 69	
“ BALANCE	...	79,814 31	
			<u>Rs. 395,611 52</u>

Brought forward

Rs. Cts.
395,611 52

Rs. 395,611 52

(Sgd.) Roland V. Norris,
Director

St. Coombs,
March 18th, 1941.

REPORT

ON

ST. COOMBS ESTATE

FOR 1940.

Superintendent.—Mr. J. A. Rogers.

ACREAGE.

			A.	R.	P.
Tea in Bearing	...	...	264	1	06
Tea—New Clearing 1937	...	...	20	0	00
Tea—New Clearing 1938	...	...	16	0	00
Nurseries	...	...	1	1	08
Fuel Clearings	...	...	33	0	00
Reserve available for planting	...	...	27	1	09
Building Sites	...	...	26	2	22
Waste Land, Swamps, etc.	...	...	26	1	14
Total	...	...	414	3	19

Weather.—Rainfall registered in 1940—93.84 inches on 247 days.

Rainfall registered in 1939—98.13 inches on 225 days.

An exceptionally severe drought was experienced during the first first four months of 1940, this was followed by cyclonic storms which swept the Island in May, which fortunately caused little material damage on this estate. The South West Monsoon was a normal one, and the year 1940 ended with very favourable weather for crop for the last three months.

Crop.—Total crop harvested in 1940—175,270 lbs.—Estimated 185,000 lbs.

Total crop harvested in 1939—151,929 lbs.—Estimated 185,000 lbs.

Yield per acre 1940—664 lbs. on 264 acres,

Yield per acre 1939—575 lbs. on 264 acres.

Except for the extreme drought in the early months, the estimated crop would probably have been exceeded. However, the crop of 175,270 lbs. in 1940 constitutes a record crop for St. Coombs, the previous record being 173,584 lbs. in 1937.

The yield of 664 lbs. per acre is the highest yield obtained from the 264 acres now in full bearing.

PRICES.

Gross Price.	Nett Price.
1940 — 174,388 lbs. — 87.62 cts. per lb. —	85.41 cts. per lb.
1939 — 151,173 lbs. — 84.74 cts. per lb. —	79.74 cts. per lb.
131,997 lbs. were sold to the Minister for Food, London, and realised 81.74 cents per lb. nett	
42,391 lbs. were sold on the Colombo Market and realised 96.83 cents per lb.	
Total 174,388 lbs. at 85.41 cents per lb. nett.	

Profit on Estate Working Account.

1940 — Rs. 46,507—equivalent to Rs. 176 per acre on 264 acres.
1939 — Rs. 36,399—equivalent to Rs. 138 per acre on 264 acres.

Cost of Production.

1940 — 59.37 cts. per pound—Estimate 58.30 cts. per pound.
1939 — 55.69 cts. per pound—Estimate 51.48 cts. per pound.

Capital Expenditure.

1940 — Rs. 16,283=9.29 cts. per lb.—Estimate Rs. 23,849=12.89 cts. per lb.
1939 — Rs. 13,595=8.95 cts. per lb.—Estimate Rs. 17,818= 9.64 cts. per lb.

Cultivation.—Artificial manuring and cultivation works have been carried out according to programme.

For 4-year pruning cycle, nitrogen at the rate of 50 lbs. average per annum is applied.

Pruning.—The whole estate (except No. 1 Field 23 acres) is to be given a trial on a 4-year pruning cycle.

The fields pruned this year generally show considerable improvement in growth of good new wood, and excellent recovery from the hard pruning given when last pruned.

In future a small acreage is to be pruned each year in January and February, in order to even out men's work.

Green Manuring.—Dadaps, which are very poor on the whole, are gradually being cut out, and replaced with Albizzias.

Crotalaria anagyroides has been used with only moderate success.

The maximum use is made of wild sunflower, which is growing luxuriantly in ravines.

Diseases.—*Phloem necrosis* again shows no marked increase on this estate.

New areas of Poria have been treated.

Tea Nurseries.—Some 13,000 Kanapediwatte stumps from the nurseries were used for supplying the 1937 and 1938 clearings during the South West Monsoon.

The nurseries will in future be needed to provide requirements of two-year-old stumps for supplying the mature tea areas.

1937 New Clearing (20 Acres).—The tea in this clearing is making steady progress in growth.

1938 New Clearing (16 Acres)—On Modified Contour System.—The intense drought in the early months of 1940 again caused very considerable casualties in the "seed-at-stake" areas of this clearing. But it is satisfactory to report that all casualties were supplied with stumps during the South West Monsoon, from St. Coombs nurseries, and also from duplicate plants in the seed-at-stake area of this clearing.

Grevilleas and Albizzias have been planted in this clearing.

Crotalarias have again proved entirely unsuccessful, which is most unfortunate, as the soil in this clearing badly requires large quantities of organic material and also cover.

Internal Cart Road.— $\frac{3}{4}$ of a mile of this road has been metalled this year, and another $\frac{1}{4}$ mile has been widened.

Labour.—At the end of 1940 there were 376 working labourers on the estate, which is equivalent to 1.40 labourers per acre in bearing, and this is sufficient for present requirements.

11,035 labourers were lent to the Tea Research Institute during the year under review.

No unrest was experienced on this estate during 1940.

Buildings.—A new temple was built during the year for the labourers on this estate, also a new maternity ward.

Extra line accommodation is under construction.

All lines now have a piped water supply, and improvements have been carried out to the supply for the upper lines.

Factory and Machinery.—No extensions or additions of note have been carried out in 1940.

Both the factory building and machinery are well kept.

General.—The estate is in good order throughout, and the tea shows considerable improvement in appearance, spread, and vitality during the last 2 or 3 years.

The year 1940 proved to be a thoroughly satisfactory one, and crop prospects for 1941 would appear to be promising.

HUBERT TONKS,

Visiting Agent.

METEOROLOGICAL OBSERVATIONS, 1940.

ST. COOMBS.

Month	Temperature				Mean Relative Humi- dity	Rainfall Inches	No. of Rainy Days	Sunshine hrs. mts.
	Mean Max.	Mean. Min.	Adopted Mean	Mean on Grass				
January	76.0	51.4	63.7	43.2	60	0.01	1	270 28
February	76.9	54.9	65.9	48.2	63	3.57	7	235 57
March	80.9	54.4	67.6	48.6	66	1.24	4	262 54
April	79.1	58.3	68.7	54.2	69	5.03	20	196 51
May	75.0	60.1	67.6	58.6	82	25.04	23	151 31
June	71.1	61.8	66.4	60.9	86	14.15	30	85 04
July	71.1	60.1	65.6	59.6	85	7.81	25	123 25
August	70.7	59.3	65.0	58.7	86	6.91	25	129 43
September	75.2	57.6	66.4	55.2	79	5.09	20	205 24
October	75.1	57.4	66.2	56.2	81	6.45	23	170 20
November	74.5	58.3	66.4	56.4	82	10.03	27	126 13
December	74.8	57.0	65.9	53.9	80	3.24	16	201 59
Annual	75.0	57.6	66.3	54.5	77	88.57	221	2,159 49
Means					Totals			

REPORT

OF

THE DIRECTOR,

TEA RESEARCH INSTITUTE OF CEYLON

FOR 1940.

Administration.—The administrative arrangements in force in the previous year were continued without change.

Finance.—The year, in spite of war conditions, has been a favourable one financially. Restriction which was at 5 per cent in the first half of the year was increased to 10 per cent in July and again reduced to 7½ per cent in November. These conditions, combined with heavy crops, resulted in exceptionally high exports of tea from Ceylon which were reflected in the yield from the cess which amounted to Rs. 344,505 as against Rs. 318,871 in 1939.

The receipts from St. Coombs Estate were also a record, Rs. 46,507 as against an estimate of Rs. 40,000, and receipts in the previous year of Rs. 36,399. With miscellaneous receipts at Rs. 4,599, the total revenue for 1940 amounted to Rs. 395,612, Rs. 25,612 in excess of the estimate and Rs. 36,017 above the figure for 1939.

Expenditure on laboratory revenue account, excluding depreciation and interest charges on the Government Loan, amounted to Rs. 233,939 against an estimate of Rs. 248,527, the reduction being in large measure the result of war conditions. After making provision for depreciation of Rs. 42,088 and meeting interest charges on the Government Loan Rs. 39,234, total revenue expenditure for the year was Rs. 315,627 against an estimate of Rs. 327,251 and expenditure in 1939 of Rs. 313,995. The surplus on general account therefore amounted to Rs. 79,814 as compared with Rs. 45,640 in 1939.

Capital expenditure amounting to Rs. 54,001 was incurred; this comprised repayment of Government Loan Rs. 35,592 and expenditure on assets of Rs. 18,409.

Liquid assets at 31st December, 1940, after allowing for specific reserves, accrued interest on the loan and liabilities to creditors, amounted to Rs. 282,777, equivalent to 70.8 per cent of the liability under the Depreciation Reserve which at the same date stood at Rs. 399,662.

St. Coombs Estate.—The first four months of the year were particularly dry, the drought being worse than in the previous year and resulting in very low crop, reaching a minimum in April in which month only 8,548 pounds of made tea were obtained. Exceptionally heavy rain followed in May, 17 inches falling in two days. Thereafter, rainfall was somewhat below average but well distributed, with the result that good cropping conditions obtained in the later part of the year. The final crop of 175,270 pounds, 664 pounds per acre, though below the estimate of 185,000 pounds was the highest collected from the present acreage and 23,341 pounds higher than the yield in 1939.

In connection with rainfall figures it is of interest to note the unequal distribution over different areas of the estate. Thus at the laboratory observatory rain was recorded on 221 days amounting in all to 88.57 inches, while at the factory rainfall fell on 247 days, the total fall being 93.81 inches.

129,477 pounds of tea were sold to the Ministry of Food under the 1940 No. 1 Contract at a price of 83.55 cents per pound and a further 2,520 pounds, B.O.P. Fannings only, under No. 2 Contract at 68.84 cents, the average price obtained for all tea for the Ministry of Food representing 75.3 per cent of the crop, being 83.25 cents per pound. 42,391 pounds were sold on the Colombo Market realising the very satisfactory gross price of Rs. 1.01 per pound.

The average for total sales was 87.62 cents gross and 85.41 cents nett, the corresponding figures for 1939 being 84.77 and 79.74 cents.

The cost of production was 59.37 cents per pound, against an estimate of 58.30 cents. Production costs were increased by the war bonus granted to labourers, 1.28 cents per pound, packing materials, 1.42 cents loss on rice and 1.30 cents on other smaller items, the result of war conditions in addition to the shortfall in crop.

80 per cent of the estimated crop for 1941 has been tendered to the Ministry of Food at a price of 15.04 pence (83.55 cents) per pound. In view of the smaller amount of tea required by the Ministry it seems unlikely, however, that the whole of this tender will be accepted. The amount of tea that will be available for sale on the local market is therefore uncertain.

No changes were made in the factory equipment during the year, with the exception of the temporary addition at the expense of the makers for purpose of trial of a Forsyth roll-breaker.

While the labour force may be becoming more politically minded it is satisfactory to record that St. Coombs has been free from labour troubles.

Food Production.—Reference was made in the Annual Report for the previous year to small scale trials in the growing of various foodstuffs. Though these trials as was then reported, were not at all encouraging, a further two acres of patna land was opened up for food production. On one acre three varieties of sweet potatoes were planted, the second acre being planted with bush lima beans. The venture has not been a success; only one variety of sweet potatoes established itself at all well and this did not subsequently grow with any vigour. The beans germinated well but show little sign of yielding a crop. The soil is of course poor, though the land was given a dressing of 25 tons of well made compost. The crops suffered also from insect attack and even more so from theft, the cost of a watcher being prohibitive. Further details of these trials will be found in the report of the Agricultural Chemist.

Staff.—Major Tubbs, who has been on military service out of Ceylon since the beginning of the war, was severely wounded early in the year but has fortunately made a good recovery and is back with his unit, the Durham Light Infantry. Much of the time of Mr. King and Mr. Lamb has been occupied with military training with the Ceylon Defence Force, and Mr. King was at the end of the year granted a Commission in the Administrative Board of the Royal Air Force Voluntary Reserve and subsequently left Ceylon for service overseas. Mr. R. L. Illankoon, Small-Holdings Officer, Gampola, who was given a Commission in the Ceylon Light Infantry, was mobilised in August and has remained on military service since that date.

The Director who was due for six months' home leave took shorter leave of 3½ months in India during which period Dr. Gadd acted for him.

No other changes occurred in the staff.

Conferences.—No major conference was held in 1940, but a Sub-Conference took place, attendance at this being restricted to delegates nominated by the Planters' Association of Ceylon, District Planting Associations, the Ceylon Estates Proprietary Association, the Low-Country Products Association and the Board, the attendance thus being representative of all interests,

The object in limiting the attendance was to permit, with smaller numbers, of a more detailed and freer discussion of the items on the agenda. The Associations represented were invited to suggest subjects for the latter, though the response to this invitation was not very marked. It was also hoped that a meeting of this kind would provide a good opportunity for delegates from the various planting districts to bring to the notice of the Institute any subjects or problems which they might wish the Institute to examine. One or two districts took advantage of this, chiefly in connection with Shot-hole Borer. It is to be hoped that the delegates appointed by district associations will not restrict their activities to the actual Conferences, but will regard themselves as liaison officers between their districts and the Institute so that the latter may be kept advised from time to time of local problems and requirements.

The following subjects were discussed at the Sub-Conference, a full report of which will be found in *The Tea Quarterly*, Vol. XIII, 1940, pp. 1-45:—

1. Discussion on certain aspects of manufacture.

(a) Costs in relation to war conditions.

(i) Fuels.

(ii) Withering materials.

(iii) Packing materials.

(b) Fermentation periods.

2. Discussion on manuring and cultivation with special reference to war conditions.

3. Discussion on Pests and Diseases.

(a) Shot-hole Borer and other pests.

(b) Diseases.

4. Discussion on Tea Selection and Propagation.

Advisory Work.—War conditions have necessarily been reflected in the volume and nature of the Institute's advisory work. Many superintendents have much of their time occupied by military duties or the supervision of other estates and have less opportunity to leave their estates. In consequence there was a sharp fall in the number of visitors to St. Coombs. For similar reasons the staff at St. Coombs had to restrict visits to estates which were reduced by about 17 per cent. while enquiries received on all subjects were lower by about 25 per cent. The nature of these enquiries was also somewhat changed. An increase in questions relating to manuring was noticeable while questions concerning diseases and pests were fewer as usually happens in times of stress. There was also less enquiry in regard to manufacture, possibly due to the fact that a large proportion of the tea crop had been sold in

advance under the Government contracts. A welcome feature of the advisory work is the increasing number of enquiries coming in from Ceylonese proprietors and superintendents in the low-country.

Co-operation with Other Research Stations.—The Director during his leave in India took the opportunity to visit the Tocklai Experimental Station and U.P.A.S.I. Research Stations in South India. Visits were also paid by him to estates in Assam, Darjeeling and South India. The opportunity was naturally taken during these visits for an exchange of views on research problems with the Directors of the Indian Stations. In particular, the details of the joint research on the Chemistry of tea which is being carried out in England was discussed with Mr. Carpenter and certain suggestions put forward in a joint note.

Mr. Harrison of the Tocklai staff was a welcome visitor to St. Coombs during the year, but it was unfortunately impossible under present conditions for any exchange of visits to take place between Ceylon and Java.

Publications.—*The Tea Quarterly* was published as usual: a reduced staff will make this a matter of some little difficulty in the coming year. Two Bulletins were also issued; No. 20 a General Index to all the Institute's Publications from 1926-1938 inclusive, and No. 21 Annual Report for 1939. The General Index has met a long-felt want and will be brought up to date at regular intervals. There was the usual wide demand for our publications from those not entitled to a free supply and Rs. 4,937 was received in subscriptions. This, added to the sum received for advertisements, made the publications more than self-supporting.

Six papers of a technical nature by members of the staff were published in different scientific journals.

TECHNICAL.

Diseases and Pests.—There was a marked decline in letters on the subject of diseases as compared with 1939. This was, however, in the main due to the fact that in that year the incidence of *Phloem necrosis* aroused widespread interest.

Dr. Bond, the officer appointed as assistant Mycologist to work on *Phloem necrosis* took up his duties at St. Coombs in February and some months were necessarily first spent in familiarising himself with the disease.

The chief problem at the moment is to find a means for experimental transmission of the disease. The great difficulty here is the slowness with which symptoms of the disease develop, the result being that a period of two years or more may be required before the results of an

experiment can be ascertained. Work would also be simplified if young plants could be used as experimental material but at present this is not practicable. No evidence has been obtained in favour of transmission by mechanical means. *e.g.*, during plucking or pruning or experimentally by needle prick. Other possibilities are that an insect, probably of very limited means of flight, is concerned or that the disease may be spread by root contact or through the soil. All these possibilities are under consideration but considerable time is likely to be required before any definite proof of transmission is stressed since obviously until the means by which the disease is spread becomes known little can be done in regard to preventative measures.

The rate of spread varies considerably, being quickest at high elevations. Thus at the elevation of St. Coombs it is probably not more than about 5 per cent per annum. In an observation plot at a higher elevation (Kandapola) the percentages of diseased bushes was found to have approximately doubled in a period of two years. This of course includes bushes in the earliest stages of the disease, and it is probable a considerable period will elapse before many of these bushes become seriously affected.

It is satisfactory to note that the incidence of the disease still seems confined to higher elevations. So far, only five cases have been reported at an elevation below 4,000 feet. One suspicious case, a single bush, was received from an estate as low as 600 feet but there was considerable doubts as to whether this was in fact *Phloem necrosis*,

Eelworms.—Considerable work has been carried out in the Mycological Division in connection with eelworms, more particularly *Anguillulina pratensis*, the species which attacks mature tea. This work has largely been connected with attempts to find some means of sterilising infected soils. Under green house conditions and in the field with annual crops some success has been obtained in other countries, in the former case by steam sterilisation, in the latter by means of applications of a chemical disinfectant Chloropicrin. The latter, however, has to be applied when the soil is free from crop and consequently cannot be employed in the case of a permanent crop such as tea. Trials have been made of other materials toxic to eelworms, especially certain silver compounds. While these are, however, highly effective in the case of suspensions of eelworms in water, their efficiency was almost entirely abolished in the presence of soil, no doubt due to the adsorption of the silver ion on the soil humus.

Eelworms are highly susceptible to desiccation and soon succumb when exposed to conditions in which the humidity is below about 70 per cent in the case of *A. pratensis* or about 50 per cent in the case of the root knot eelworm, *Heterodera marioni*. Though this fact is not likely to be

of practical importance in the field it does provide a safeguard in the case of soil required for filling baskets in tea nurseries, since sun-drying of such soil for a sufficient period — about a week — has resulted in relative immunity from eelworm attack.

The life-history of *A. pratensis* has also been under study. Fortunately, the rate of egg laying is slow, the maximum so far observed being 2.4 per day with an average of 1.65. The complete life cycle is probably about 46-48 days.

Investigations are also in progress in regard to the relative "resistance" of different species of plants to eelworm attack. The interesting observation has been made that eelworms enter the root system of such "resistant" plants quite freely, but for some reason not yet explained soon abandon these again before or after laying only a few eggs. Such work is obviously of importance as a means of selecting more resistant green manure crops.

Insect Pests.—The Entomological Division has been associated with the work of the *Phloem necrosis* officer in the search for a possible insect vector of this disease and several additional species have been added to the list of possible suspects. Amongst these, brown scale (*Saissetea coffeae*) seems to merit particular attention. This is a phloem feeder and is common in *phloem necrosis* areas, its general habits also fit in with the way in which the disease spreads. Inoculation experiments with this and other species have not yet, however, given any positive results though at least another year must elapse before negative results can be regarded as final.

The parasite, *Macrocentrus homonae*, against Tortrix now seems to be pretty generally established throughout the tea districts. The success obtained with this parasite has thoroughly justified the suspension of the regulations made under the Plant Protection Ordinance in regard to Tortrix.

This success has not been without its embarrassing side since demands were immediately made for the production of an equally successful parasite against Shot-hole Borer. The demand was vigorously presented at the Sub-Conference held in March. As has, however, been previously pointed out, the problem with shot-hole borer is a much more difficult one owing to the habits of the beetle which spends most of its life *inside* the attacked branch whereby it is largely protected by attacks from parasites or predators. Apart from that, enquiries made in many quarters have moreover failed up to date in revealing any likely parasites which could be imported and tested.

Considerable work has, however, been in progress in connection with shot-hole borer, both in regard to its life-history and in order to assess the damage done and how far this may be influenced by different treatment *e.g.*, hard or light plucking, etc. Some preliminary data on these investigations will be found in Mr. King's report and a further analysis of the results will, it is hoped, be published at an early date.

The views held in regard to shot-hole borer and its status as a pest are so divergent that it was considered desirable to obtain more reliable data from heavily infected estates. The co-operation of the Planters' Association of Ceylon and the Ceylon Estates Proprietary Association was sought in this matter and was of course freely extended. It is disappointing, however, to have to record that the response from estates was practically negligible. Unless such data can be collected and analysed it is naturally difficult for the Institute to draw up plans for a more systematic examination of this pest and to assess the damage for which it is directly responsible.

Nettle Grub was rather more prevalent in the Uva district than in the past few years though a relatively small number of estates were affected. Assistance was given to the estates concerned by the staff of the Passara Sub-Station. Generally speaking, collection of larvae and cocoons or spraying with soap solution kept attacks within bounds, but in one case the attack was sufficiently severe to necessitate pruning of the area concerned. Here again requests for the appropriate parasite were soon forthcoming.

Agricultural Chemistry.—A considerable proportion of the advisory work in this Division has been concerned with revised manual programmes for estates necessitated by changes in the fertiliser position. Little or no evidence has been forthcoming as to any reduction in the manuring of tea. Nor has there in fact been any particular reason for this to occur in spite of inevitable disturbances due to war conditions. Imports of fertilisers, particularly nitrogen, were actually higher in 1940 than in previous years, and though a greater proportion of these than formerly may have been utilised by the rubber industry, tea has been able to obtain adequate fertiliser supplies, with the exception of potash which was rationed in the latter part of the year, and the increase in price has not so far been serious. Supplies of certain manures, such as ammonium sulphate, have been reduced but substitutes such as nitrate of soda and groundnut cake have been available. In regard to potash, however, it seems likely that for some time to come estates will have to be content with the smaller applications than were customary in normal times. Unless this state of affairs should continue for a much longer period than at present appears probable, there is no reason, judging from the results of the Institute's manurial experiments, to anticipate that any serious damage will result from this reduction in potash manuring.

The use of nitrate of soda in partial replacement of ammonium sulphate was regarded with nervousness in some quarters, but having regard to the proportion in which this has been applied and the fact that mixtures have also contained reasonable amounts of ammonium sulphate there was no real reason for anxiety. If and when supplies of sulphate of ammonia become exhausted it may be desirable to limit the nitrogen applied as nitrate of soda to about one-third of the total nitrogen. The indications are, however, that in such circumstances supplies of nitrate of soda also will only be available at enhanced rates which will not compete with groundnut cake. It is therefore likely to be replaced to a considerable extent by groundnut cake so long as supplies of the latter are freely available from India.

With the cost of fertilisers tending to increase, the question of using these to the best advantage assumes even greater importance. It is therefore opportune that fuller data in regard to the results of omitting the conventional pruning mixture and delaying the first application of manure until the bush is again bearing leaf and able to utilise to the best advantage the manure supplied, are now available. In Dr. Eden's report will be found comparative yield figures indicating the results obtained when this first application has been delayed for three and six months respectively after pruning. The advantages of this practice are clearly shown and it is of interest to note in the case of the six months' delay, how the yield increments persist throughout the cycle. Data are also provided to shew that this gain in yield has not been offset by any adverse effect on the growth of the wood, there being no significant difference in the weight of pruning wood whether the first manurial application was given at the time of pruning or three or six months later.

To supplement these figures, further experiments have been laid down to determine the best distribution of manurial quantities during the rest of the pruning cycle. These should give valuable information in regard to the cumulative effect of manuring.

Data are also given in the same report in regard to the effect of various levels of manuring on the nitrogen content of the pruning leaf and wood. It will be seen that there is an inter-reaction between the nitrogen and potash figures but that phosphoric acid has had no influence on the nitrogen of the leaf.

Similar data in regard to the potash and phosphoric acid content will be available shortly.

Further evidence accumulates as to the method of utilisation of nitrogen by the tea bush. The suggestion is made that while the bush is leafless little nitrogen absorption takes place. On the other hand, after leaf formation has occurred, the nitrogen available is almost immediately

absorbed and stored, these reserves being rapidly drawn upon when favourable climatic conditions occur, as evidenced by the familiar rush periods.

Plant Selection and Propagation.—Major Tubbs has of course been absent through the year on military service. Thanks, however, to voluntary assistance rendered by Mrs. T. E. T. Bond it has been possible to maintain active investigations on tea selection and propagation.

In regard to selection, yield records have been completed on some 2,500 individual bushes while similar tests are still proceeding on a further 273. The basis of selection from these tested bushes is stringent and the number retained for further examination is about 93. Yield, however, is not the only factor involved, quality is of equal importance. At the Sub-Conference held in March a description was given (*Tea Quarterly*, Vol. XIII, 1940, Part I, p. 43) of the method which has been devised for manufacturing leaf from single bushes and it was mentioned then that wide variations had been found in the quality of the resulting teas. This fact of course provides another basis of selection. So far, manufacture tests have been completed on 36 bushes while similar tests on another 30 are in progress. In this connection our very grateful thanks are due to Mr. R. H. Horne of Messrs. Forbes & Walker who has carried out the tasting of these individual bush samples and taken great interest in this work.

In regard to propagation, as is already known, the method found most suitable for Ceylon conditions is the use of single node cuttings, and work during the year has been largely concentrated on improvements to the technique of this process in order to obtain a higher percentage of successful strikes and to avoid losses in later stages after rooting has occurred. Considerable success has been obtained in this work of which full details will be found in the report of the Acting Plant Physiologist. In the earlier work peat-moss was used as the rooting medium; later experiments have indicated that this can advantageously be used mixed with at least an equal weight of soil, a fact which will of course reduce the cost of propagation.

In regard to the type of material used for propagation, the results to date are clearly in favour of single leaf cuttings, the percentage of success obtained with cuttings of two or more nodes being much reduced.

Red-wood cuttings on the whole seem likely to give better results than those from green-wood but the data on this aspect are not yet complete.

Further experiments have also been carried out on the effect of growth-promoting substances in accelerating rooting, and it will be seen from the figures quoted in the report that very beneficial results have been obtained from the use of Hortomone A.

Biochemistry and Manufacture.—The time of Mr. Lamb, the Institute's Biochemist, has been considerably occupied with military training necessitating frequent absences in camp. This has naturally caused some interruption in the work of the Department which has chiefly been concerned with (a) firing experiments, (b) rolling experiments with special reference to different types of battens and (c) more theoretical work on the mechanism of fermentation.

The main results of firing experiments, which were designed to compare the effect of firing at different temperatures, have recently been published in *The Tea Quarterly* (1940, Part IV). The interesting features are the unfavourable results obtained with high firing temperatures (210°) and the good points, while fresh, of teas fired at 160°. Unfortunately there are doubts as to the keeping qualities of the latter teas and until this factor is cleared up a firing temperature of about 190° must be considered the best.

The experiments on batten design are likely to yield results of practical importance. They indicate that the influence of the battens on the outer part of the roller table is relatively small, the rolling effect depending chiefly on the design of those situated at the centre of the table. Two types seem desirable, the first for the earlier rolls to give the maximum twisting effect and the second, of a cutting type, for reducing the bulk. By a combination of suitably designed battens of these two types it may be possible to accelerate the rolling process and to obtain an improvement in fermentation somewhat similar to the Clivemeare process while retaining the orthodox appearance of the leaf.

Work on the mechanism of fermentation has made considerable progress and three technical papers on this subject have been accepted for publication in scientific journals at home. Similar work is proceeding at Tocklai and close contact is being maintained between the two Institutes on this subject. This is the more necessary since the results obtained to date are not altogether parallel and friendly argument is proceeding to clear up these divergences. Actually they may be more apparent than real having regard to the different conditions obtaining, particularly temperature, in the two centres.

As previously indicated, this work is intended to link up with the work on the chemistry of tea which is being carried out in London by Dr. Bradfield. War conditions have necessitated some modifications in the organisation of this work. It is hoped, however, that it will be possible to include in the programme an examination of fresh material as well as of made tea, since it is a wider knowledge of the chemical make-up of the former that is chiefly required to assist work on manufacture in the producing countries.

War conditions have naturally raised problems in regard to the provision of packing materials and discussion on this subject took place at the Sub-Conference (*The Tea Quarterly*, Part I, p. 11). So far as locally made chests are concerned the warning then issued by the Institute against the use of materials showing any evidence of borer attacks was opportune as it was not long before difficulties arose in this connection. A considerable number of different types of wood, some imported and some local, was examined at the request of the Forest Department and local importers in regard to their suitability for tea chests.

As already mentioned under tea selection, the Biochemical Department is responsible for the quality tests on leaf from individual bushes and has as usual carried out routine manufacture of leaf from the manual and other experiments.

Small-Holdings.—Work continued on Small-holdings in the Gampola district and the Southern Province and successful competitions were held in both areas. In August, however, Mr. R. L. Illankoon, the Small-holdings Officer, Gampola, was mobilised and work in this area was temporarily suspended. It is hoped it will be possible to arrange for Mr. Illankoon to be relieved from military duty for short periods in order that he may at any rate be able to maintain some contact with the small-holders in his district.

In the competitions excellent work has been done by most of the competitors; the advantages of green manures and shade trees are now generally recognised and *Gliricidia* in particular have been planted in large numbers. Much attention has also been paid to the improvement of drains and terracing, and a good deal of supplying has been carried out on the more progressive holdings.

It is to be regretted, however, that taking small-holders as a body, the larger proportion tend to neglect their holdings badly, the cash received for coupons being utilised for other purposes.

Cordial thanks are due to the headmen, village committees and many private individuals in the areas where work has been proceeding for the encouragement and assistance they have given to our small-holdings officers.

Acknowledgments.—As usual the Institute has received valuable support and co-operation from the Ceylon Association in London, the Planters' Association of Ceylon, the Ceylon Estates Proprietary Association and our cordial thanks are due to these bodies for the assistance they have afforded in various matters.

Grateful acknowledgments are also due to many Colombo Agencies and to Estate Superintendents who have granted facilities for experimental work on estates or assisted in other directions. Messrs. George

Steuart & Co. and the Superintendent of Gonakelle Estate have as usual, afforded us every help at the Passara Sub-Station. The Superintendent, Sarnia Estate kindly helped in connection with Shot-hole Borer enquiries and Messrs. Leechman & Co., and the superintendents of many of the Nuwara Eliya Tea Company's estates have co-operated in investigations on *Phloem necrosis*.

Particular thanks are due to the Colombo Firms and Tasters who have continued under very difficult circumstances to report on our experimental teas. Invaluable help in this connection has been received from Mr. R. H. Horne, Mr. M. P. Saunders, Mr. J. M. Westwood, Mr. H. W. T. Sherwood and Mr. A. J. Pelly-Fry and we are greatly indebted to these gentlemen for all they have done. War conditions made it impossible to continue our tasting arrangements in London. Our very cordial thanks are due, however, to Messrs. Wilson Smithett & Co. and Messrs. George White & Co. Ltd. who have given us all possible help in this direction. In Colombo acknowledgments are due to Messrs. Forbes & Walker, Messrs. Harrisons & Crosfield Ltd., Messrs. Whittall & Co., Messrs. Colombo Commercial Co. Ltd., Messrs. Carson & Co. Ltd., Messrs. Brooke Bond (Ceylon) Ltd., Messrs. Heath & Co., Messrs. Lipton Ltd., Messrs. Sommerville & Co., Messrs. George Steuart & Co., Messrs. Mackwoods Ltd., Messrs. Lee, Hedges & Co., Ltd., Messrs. Leechman & Co., and Messrs. E. John & Co. for their valuable help and co-operation.

Particular thanks must be accorded to Messrs. Forbes & Walker who, in addition to all they have done in connection with experimental samples, have taken endless trouble in regard to the disposal and shipment of our teas.

We have continued to receive valuable advice and assistance from Mr. F. J. Whitehead and Mr. H. Tonks, our Visiting Agent, and to both these gentlemen our cordial thanks are extended.

The Reports of the Scientific Staff are appended.

ROLAND V. NORRIS,
Director.

REPORT

OF

THE MYCOLOGIST

FOR 1940.

Staff.—In addition to his own duties the Mycologist acted for the Director during the latter's leave from August 7th to November 30th, Throughout the year he supervised part of the work of the Physiological division, and from October 28th to December 23rd he had acting charge of the Entomological division while the Entomologist was on military service.

Dr. T. E. T. Bond joined the staff of this division on February 8th. He took charge of the experiments concerning *Phloem necrosis* then in progress, and has since devoted his whole time to the study of that disease and allied problems. A separate report of his investigations is attached.

Mr. L. W. Perera worked in the mycological laboratories from April 11th to May 8th while undergoing specialist training before taking up his duties on a local estate. Mr. Perera is not a member of the Institute's staff, but the Mycologist has assisted in the direction and supervision of the scientific investigations carried out by him on the estate.

Advisory.—485 letters were received and 441 despatched ; 316 consignments of diseased plants were received for examination and report. 21 visits to estates for investigational and advisory purposes were made in the Agrapatna, Dimbula, Dickoya, Kandapola, Maskeliya, Nuwara Eliya, Passara and Uda-Pussellawa districts.

Publications.—In addition to papers published in *The Tea Quarterly* the following articles was also issued from this division :—

'Lily Mosaic.' By C. H. Gadd and C. A. Loos, *Tropical Agriculturist*, Vol. XCIV, pp. 160-167 (1940).

Albizzia Seedling Leaf Disease.—In 1914, Petch reported the occurrence in the Ratnapura district of a leaf disease of Albizzia seedlings, characterised by the presence of pale-brown spots on the leaflets which subsequently fall off. Associated with the disease was a species of *Cerato-*

phorum which he later named *C. albizzae*. Since then the occurrence of that disease has rarely been reported until this year, when in April and May, specimens of diseased Albizzia seedlings were received from the Balangoda and Dimbula districts. The specimens in all cases were seriously defoliated. The leaflets remaining on the plants had pale-brown spots caused by *C. albizzae* and the same fungus was found on the fallen leaves. Little can be done to benefit the young plants when defoliation has progressed far. Treatment, as by spraying with a copper fungicide, is essentially preventive, and to be of any use must be carried out early before the plants are seriously damaged.

Root Disease.—In the Annual Report for 1936 ⁽²⁾ comment was made concerning the speed at which deaths of tea bushes occurred from Brown root disease (*Fomes noxius*) after the felling of Grevillea trees. In May this year, two dead tea bushes were received from an estate in the Haputale district with the information that their sites were adjacent to the stump of a Grevillea tree felled in June, 1939. Both bushes had been killed by Brown root disease. In this instance the tea bushes died just within twelve months of the Grevillea being felled.

Tea bushes killed by *Armillaria mellea* were received from an estate in the Uda-Pussellawa district. In that instance the fungus had also attacked *Tephrosia vogelii* intergrown with the tea.

Tea Scab.—This disease though rarely of economic importance is frequently found on the older leaves of the tea bush but it rarely, if ever, affects the flush. Scabbed leaves do not usually attract attention until the disease is advanced, when characteristic scabs occur on the upper surface of the leaves. These are usually large and irregular in shape often extending over a great part of the leaf; they are intermingled black and grey, and are irregularly blistered and cracked. The discoloration does not extend as a rule to the undersurface of the leaves.

Until recently the cause of the disease was unknown. A similar disease has been found on tea leaves growing at Cantareira, Sao Paulo, Brazil with which was associated a fungus, described as *Elsinoe theae* by A. A. Bitancourt and Anna E. Jenkins ⁽¹⁾ of the Bureau of Plant Industry, Washington. The same fungus has been found by them on scabbed tea leaves from Ceylon.

NEMATODES.

Chemical Control.—Control of nematode pests under greenhouse conditions can be effected by steam sterilisation of the soil, but under open conditions it is much more difficult to achieve. So far as annual or temporary crops are concerned experience has shown that with carefully

planned rotations including immune crops, or by dry fallowing, the problem is not entirely hopeless or insoluble. Chemical control has not on the whole proved efficient, and those substances which have given the best results, *e.g.*, chloropicrin, must be applied at a time when there is no crop on the ground. With permanent plantation crops such as tea, crop rotation, dry fallow, and the use of the more efficient chemicals to destroy nematodes in the soil are impracticable.

Hovy (4) however has drawn attention to the value of silver ions in the control of the root nematode (*Heterodera marioni*) and has shown that the silver ions will kill *Heterodera* larvae at concentrations harmless to the growth of tobacco plants.

In order to test the efficacy of silver solutions against *Anguillulina pratensis* the following method was used. To 5 c.c. of the solution to be tested was added one spot of water containing a large number of eelworms collected from tea roots. The solution was shaken periodically for aeration and examined after 4 and 24 hours. In order to determine the effect of the solution on the eelworms, small quantities of the solution were placed on microscope slides and the living and dead eelworms counted until 50 had been seen.

In a preliminary test it was found that a solution of silver nitrate consisting of 1 part silver nitrate in 100,000 parts of water, killed all the eelworms within 4 hours, but a solution 1:1,000,000 did not give 100 per cent kill after 24 hours. When, however, a solution 1:1,000 was first filtered through 4 inches of soil the killing properties of the filtrate were almost completely lost. Only 40 per cent of the worms were killed after 24 hours.

Silver ions are readily adsorbed by organic matter; so when the silver nitrate solution was filtered through soil the greater part of the silver remained within the soil attached to the organic matter. It seemed possible that this difficulty might be overcome by the use of soluble organic silver compounds such as silver proteinate.

In Table I are given the results of some of the tests made with silver compounds obtainable in Ceylon. The figures given are the means of two tests.

Silvol and Argyrol are trade names for silver proteinate, and as silvol was obtained from two sources they are designated A & B. Neo Silvol is a trade name for a colloidal silver iodide and Collosol argentum is a colloidal silver. The results with silver proteinate are somewhat conflicting, particularly after filtration through soil; no satisfactory answer can be offered for the divergent results.

TABLE I.

The percentages of *Anguillulina pratensis* killed in 4 and 24 hours by solutions of silver compounds at a strength of 1 part silver to 2,000 parts water, before and after filtering through 4 inches of soil.

		Before filtering		After filtering.
		4 hrs.	24 hrs.	24 hrs.
Silver nitrate	...	100	100	23
Silver proteinate	...	100	100	0
Silvol A	...	22	72	36
Silvol B	...	20	100	22
Argyrol	...	45	85	3
Neo Silvol	...	0	2	—
Collosol Argentum	...	14	100	3

An attempt was made to determine the value of silver nitrate and silver proteinate for killing eelworms in soil by first loading a soil with *A. pratensis* from tea roots before treatment. Varying quantities, up to 1 gm. per 10-inch pot, were added to the soil before young healthy tea plants and *Tephrosia vogelii* plants were transferred to the pots. Control plants were grown in the same eelworm-infected soil but without the addition of a silver salt. When the roots of the plants were examined some months later, no infection was found in either the treated or control pots. Although the experiment failed in its main purpose, it demonstrated that neither silver nitrate nor silver proteinate in the quantities used had any detrimental effect on the growth of young tea plants or *Tephrosia vogelii*.

Desiccation.—The following experiments were undertaken to ascertain to what extent *A. pratensis* could withstand desiccation. Ten adults isolated from tea roots were placed on a microscope slide in a spot of water which was then allowed to evaporate. The disappearance of the last thin film of water was watched under a microscope and a note taken of the time at which it disappeared. After a given time, fresh well-aerated water was placed on the worms in an attempt to revive them. Those which failed to revive after 3 hours were counted as dead, as the prolongation of that time and other methods did not increase the number of survivors. Wet and dry bulb temperatures were taken at the beginning and end of each experiment in order to determine the relative humidity at the time. The experiment was repeated on 4 occasions and the results are given in Table 2. These experiments show that *A. pratensis* adults cannot survive exposure to a relative humidity below 70 per cent for more than 4 minutes, but at higher relative humidities they survive longer.

TABLE II.
Effect of desiccation on *A. pratensis* adults.
10 worms were used for each test.

Time of Exposure	Experiment 1		Experiment 2		Experiment 3		Experiment 4	
	Relative humidity.	Number killed.	Relative humidity.	Number killed.	Relative humidity.	Number killed.	Relative humidity.	Number killed.
	%		%		%		%	
1 minute	62	0	64	0	71	0	76	
2 minutes		5		0		5		
3 "		10		7		9		
4 "		10		10		10		
7 "								2
8 "								1
9 "								3
10 "								3
11 "								1
12 "								10
13 "								10

Godfrey and Hoshino ⁽³⁾ have studied the effect of desiccation on the root knot nematode (*Heterodera marioni*) in great detail, and shown that at 50 per cent humidity, larvae survived 3½ minutes, egg-masses 2½ hours, and eggs protected by root-gall tissues 1½ days. At higher relative humidities survival was longer; for instance, at 90 per cent humidity, larvae survived for 25 minutes; egg-masses for 8½ hours, and eggs in root-gall tissues more than 20 days' exposure.

Although the effect of desiccation on *A. pratensis* has not been studied to the same extent as on *H. marioni*, it is evident that *A. pratensis* is equally susceptible to desiccation as is *H. marioni*.

Disinfection of Soil.—The fact that *A. pratensis* and *H. marioni* cannot long survive desiccation has a practical value in that it affords a method of freeing soils of these eelworms without the use of chemicals. Where basket plants have to be grown because nursery sites have become infected by eelworms, usually *H. marioni*, the soil should be sieved to free it from roots and then sundried before being placed in the baskets.

A soil, heavily infected by *A. pratensis* was sundried during a week in November. The moisture content was thereby reduced to 1.7 per cent. *Tephrosia* plants grown in that soil remained free from eelworm attack whereas similar plants grown in the same soil before sundrying were heavily infected.

Life-History of *Anguillulina pratensis*.—As *A. pratensis* lives within roots the study of its life-history entailed the examination of a large number of roots after infection on known dates. As that nematode attacks and breeds within the roots of *Tephrosia vogelii* as readily as it does in tea, and because seedling *Tephrosia* plants can be raised more quickly than tea seedlings, *Tephrosia* was selected as the host plant for this detailed study. A paper has been prepared for publication in which the methods used are described and the data collected during the investigation are given. It will be sufficient here to briefly summarise the conclusions.

The maximum number of eggs laid by one female was 64 during a period of 5 weeks, which is an approximation of the maximum period of egg-laying. The average rate of egg-deposition was 1.65 eggs per day and the maximum rate observed was 2.4 per day. The eggs laid by any worm were usually found close together forming a 'nest,' this indicates that, after entry into a *Tephrosia* root, the female ceases her migrations and settles down to a sedentary existence. The eggs hatched after an interval of 15 to 17 days, and the larvae remained near the mother. The larvae became adult in 15 to 16 days but the females did not begin to lay until they were about 31 days old. The life cycle (egg to egg) therefore occupies about 46 to 48 days.

Resistance and Susceptibility.—The accuracy with which nematodes locate their preferred host plant is often astonishing, and although satisfactory explanation has been offered of the means by which location is made, few suggestions have been made for the somewhat surprising preferences shown by some eelworms. That such preferences occur is of the greatest economic importance, as therein lies the best possible means of combating the eelworm problem. The preferred plant is commonly termed 'susceptible,' and that in which the eelworms are rarely or never found is termed 'resistant.' Much work has been done towards the discovery and possible breeding of crop plants resistant to nematodes, and such successes as have been achieved indicate the probable value of further endeavour along those lines.

A start has been made towards a study of host selection as exhibited by *A. pratensis*, and attempts have been made to evaluate (1) the attractiveness of roots to the nematode and (2) the behaviour of the nematodes after entry into the roots.

A method has been devised for measuring the relative attractiveness of roots and from the results obtained it would appear that *A. pratensis* is attracted towards the roots of a resistant plant such as *Desmodium gyroides* as readily as towards those of a susceptible plant like tea. Moreover the nematodes enter the so-called resistant roots, but after a time

they may leave the roots before or after laying a few eggs. A resistant plant is therefore *not* one which resists the entry of nematodes into its roots. Its relative immunity must therefore be dependent upon some reaction between the root and the nematode which causes the nematode to leave or to be unable to breed normally.

C. H. GADD,
Mycologist.

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REPORT

OF

THE ASSISTANT MYCOLOGIST

FOR 1940.

PHLOEM NECROSIS.

During the first half of the year, a large amount of time was spent in becoming thoroughly familiar with the disease and in examining and analysing the records of experiments previously initiated. Twenty visits have been paid to eleven estates.

The disease has now been identified from 113 estates; only 10 new instances were reported during the year. A large number of gaps in the distribution remains to be filled in, and the further co-operation of estate superintendents in reporting the suspected presence of the disease is invited. Only five cases of *Phloem necrosis* have been confirmed from estates below the 4,000 ft. level. An interesting specimen was sent in from an estate in the Ratnapura district, at an elevation of about 600 ft. only. The bush was markedly necrotic in external appearance and an internal necrosis was found affecting the phloem and other tissues. However, it could not be diagnosed with certainty as *Phloem necrosis*, nor could any other bushes be found in this condition.

Field Observations.—A reasonably accurate but at the same time rapid method of detecting and recording the disease is essential. In general, inspection of the bush and examination of a few leaves cut or broken off at the petiole (leafstalk) gives a reliable diagnosis. Various tests have shown that a satisfactory agreement with the previous records obtained by the Mycological division has been reached.

Observation plots are being maintained on a number of estates in various districts. Some of these have been running for more than two years and are providing useful information as to the rate and manner of spread of the disease. The rate of spread of the disease seems to vary in different localities, and it may be extremely rapid. Thus, in one large plot in the Kandapola district, the percentage of diseased bushes has almost exactly doubled in two years, the last record giving 53 per cent or 524 necrotic out of 985 bushes. These figures, while sufficiently alarming, refer to the total incidence of the disease, and make no allowance for differences in the severity of infection of individual bushes. The

evidence so far available suggests that several years may elapse before severe symptoms are developed by a newly-infected bush, and it may even require a couple of years before a reliable diagnosis of the disease is possible. Further reference to this point will be made later. At St. Coombs, and probably at the lower altitudes generally, the rate of spread of the disease in the field is relatively low, and may only be of the order of 5 per cent each year. The disease is also less characteristic in its effects at these altitudes, and is frequently difficult to identify except by microscopic examination.

Statistical methods have been employed in examining the occurrence of necrotic bushes in the various observation plots, and it appears that the disease, in addition to a discontinuous or random dispersal, also shows a distinct tendency to spread from bush to bush along and across the rows. This bears out the general impression that the diseased bushes tend to occur in small groups or patches. The establishment of this tendency for bush to bush spread will have an important bearing on the ultimate interpretation of the mechanism of dispersal. The most obvious suggestion, of a mechanical dispersal during plucking or pruning, has so far received no support from the experimental work and in fact there is considerable *a priori* evidence which renders this possibility unlikely. Other interpretations which suggest themselves are that an insect of very limited powers of flight is involved, or that the disease can be spread by root contact or through the soil. Discontinuous distribution, as indicated by the occurrence of isolated necrotic bushes (or, for instance, by the spread of the disease to new estates or districts) must also be accounted for.

A field experiment has been laid down on an estate in Kandapola in which the progress of the disease will be recorded in 900 bushes arranged in three series of plots receiving the following treatments respectively: (a) Removal, at definite intervals, of all bushes considered non-productive; (b) Removal, as before, of all bushes which can be diagnosed as necrotic; (c) Controls, from which no bushes are removed.

This experiment should provide additional evidence on the nature of bush to bush dispersal and should also give some indication of the efficacy of the control measures at present recommended to estates.

Experimental Work.—The major problem to be solved is to provide a means of experimental transmission of the disease. Until this is done, no advance along other lines is possible, as no hypotheses put forward can be confirmed. Two difficulties have greatly hampered the experimental work. Firstly, as noted above, there seems every likelihood that the development of symptoms in the plant is extremely slow, which involves waiting two or more years for an answer to every experiment, and secondly, there is the fact that the disease has so far been recognised only in mature bushes and has not yet occurred naturally in young plants or supplies.

Young plants are obviously more convenient to work with and in fact for certain types of experiment they are a necessity. This second difficulty will, it is hoped, be overcome by the use of cuttings which will have the additional advantage of uniformity of origin if desired. A considerable stock of necrotic cuttings is being raised. Experiments have shown that increased rooting percentages can be obtained by the use of "Hortomone A," and this is now a routine procedure. The necrosis persists in the new growth from necrotic cuttings, and there is every hope of obtaining a fair stock of young necrotic plants for experimental work. The continued absence of the disease from young plants of the high jât type at present used for supplying suggests the possibility of a high degree of resistance or even complete immunity in this type. Accordingly, a number of cuttings and seedlings are being raised also from low jât bushes of the type which is common in the badly necrotic districts.

The three methods of transmission which must be attempted are mechanical methods, grafting, and the use of insect vectors. As already mentioned, no support has been forthcoming for the idea of mechanical transmission, *i.e.*, by needle prick or the transference of inoculum by plucking or by pruning. Several previous experiments along these lines have been examined during the year and have given negative results.

Grafting methods are regarded as promising and it seems likely that the disease has been transmitted at least once by grafting (T.R.I. Bulletin 19, p. 29) although not yet in its typical form. Inarching has so far proved the most reliable method of obtaining a graft union. By this method the stock and scion are brought together and allowed to unite while the latter is still growing on its own roots. Seedling grafts, *i.e.*, by the insertion of a scion into the taproot of a young seedling, have also proved useful. New grafting methods attempted during the year have included "Crown-grafting" (a process resembling the top-working of fruit trees) "Couple-grafting" (a new method from Java) and "Whip-grafting" of healthy scions on to detached portions of necrotic root. The last two are the most promising and it is hoped that a number of unions will be obtained. An interval of at least three months appears to be necessary for full union between stock and scion to take place and an experiment was carried out to determine the possible value of "Hortomone A" in accelerating this process. The experiment was inconclusive and will be repeated.

A number of insect inoculation experiments has been carried out using various species from among those noted in T.R.I. Bulletin 21, pp. 41-42. No transmission of the disease has so far been obtained although here again an interval of a year or more should probably elapse before any of the experiments are discarded. In the search for possible vectors of the disease, account should be taken of the known facts of its distribution and manner of spread in the field. From this point of view, most of

the insects listed appear too widespread and also too active to be considered as vectors except under special circumstances. Thus, it may be found that the virus can be transmitted only under certain weather conditions which are of relatively infrequent occurrence, or that a particular stage in the pruning cycle is required. On the other hand, some rarer or less active insect may be involved, for which no special conditions need be assumed. Other possibilities of course exist, but enough has been said to indicate the nature of the problem and the difficulties which surround it.

In co-operation with the Entomological division, special observations have been carried out on the brown scale (*Saissetia coffeae*). This insect is common in the severely necrotic areas and owing to its (ordinarily) limited powers of movement, was thought to have some possible significance for the bush to bush spread of the disease. Microscopic investigation has shown that the insect is a phloem feeder.

Interpretation of the results of experiments with young, potted plants has been somewhat hampered on occasions by the occurrence of a necrosis affecting the phloem in controls and inoculated plants alike. This condition is not regarded as true "*Phloem necrosis*" as the symptoms under the microscope are fairly easily distinguishable. The available evidence suggests two factors which may be involved, namely crowding or water-logging of the roots in the pot and the presence of an unhealed wound as, for instance, an imperfect graft union. An experiment is in progress to confirm these hypotheses with a view to avoiding this complication in future.

Laboratory Investigations.—Attempts have been made to provide a means of distinguishing the early stages of infection by micro-chemical methods, but the results obtained so far are not encouraging.

Anatomical work has been undertaken with a view to providing a background for future studies on the extent of the virus in the plant and its paths of movement into the developing organs. A fairly complete picture has been obtained of the course of development of the phloem tissue in the stems. This will be extended to the other organs of the plant.

The distribution of necrotic symptoms in the shoot has been more fully investigated. The banji shoot is usually necrotic throughout, including the apical bud. As the latter expands and the new flush develops, the necrosis is at first confined to the base, *i.e.*, in the region of the fish leaf, and it is only when the rate of growth decreases that it can be observed to spread. The apex becomes necrotic once more soon after the flush growth ceases.

T. E. T. BOND.
Assistant Mycologist.

REPORT

OF

THE ENTOMOLOGIST

FOR 1940.

Advisory.—604 letters were received, 719 despatched, and 402 lots of specimens were sent in for examination. 60 visits to estates were made during the year, the great majority being in the Uva district.

Staff.—There was no alteration in the staff during the year, but the Entomologist was mobilised in the Colombo garrison from October 27th to the end of the year.

Phloem necrosis and Insect Vectors.—The search for sucking insects that may be concerned in the spread of *Phloem necrosis* has added several more forms to the list of those already known, but most are unnamed. The following is a list of those collected to date from tea :—

<i>Jassidae</i>	...	...	11 species
<i>Capsidae</i>	...	...	4 „
<i>Delphacidae</i>	...	...	2 „
<i>Membracidae</i>	...	...	1 „
<i>Psyllidae</i>	...	...	1 „
<i>Flatidae</i>	...	...	1 „

In addition to these, 3 species of Scale Insects (*Saissetia coffeae* Wlk., *Pinnaspis theae* Mask., *Aspidiotus lataniae* Sign.), 2 species of Thrips (the black thrip, *Heliothrips haemorrhoidalis* Bch. and an unnamed species), Scarlet Mite (*Tenuipalpus obovatus* Down.), Red Spider (*Tetranychus bioculatus* W-M.), and Tea Aphis (*Toxoptera aurantii* Boyer.) have all been recorded from bushes affected by *Phloem necrosis*.

Life cycles of three of the Jassids have been worked out as follows :—

Species	Egg	Average periods (days);			Stages:—		Average total	Average temperature
		1st	2nd	3rd	4th	5th		
1. <i>Eutettix apricus</i> Mel.	18	8	6	5	6	7	32	71°F.
2. <i>Neodartus acocephaloides</i> Mel.	23	19	16	21	15	31	102	72°F.
3. <i>Vulturnus ornatus</i> Dist.	28	14	11	13	17	16	71	71°F.

Only the first two laid eggs on tea under laboratory conditions, from insects bred there. *Vulturinus* females, brought from the field, laid eggs in tea readily, but no adults bred in the laboratory would do so.

The pre-oviposition period of *Eutettix* was found to be 12 days, and that of *Neodartus* 30 days, and the number of eggs laid by them, 51 and 55 per female respectively.

The longevity of the adults is tabled below :—

	Male	Female
<i>E. apricus</i>	36 days	32 days
<i>E. acocephaloides</i>	17 "	58 "
<i>V. ornatus</i>	11 "	16 "

Tortrix.—Several requests from different parts for the parasite *Macrocentrus homonae* were received during the year, but it was found that the parasite was established everywhere except on an estate near Kandapola. The parasite was recorded and identified in Peradeniya, Hewaheta, Madulsima, Passara and Nivitigala as well as the districts where it was known to be.

On St. Coombs, there were times when Tortrix could not be found at all, but it increased slightly towards the end of the year and was found to be parasitised to the extent of 90 per cent.

The suspension of the Plant Protection Ordinance in respect of Tortrix, which took place in May, 1939, appears to be abundantly justified.

Shot-hole Borer.—At the Sub-Conference held by the Institute in March, there was a discussion on this pest, initiated by Mr. Grant-Cook. A full report has appeared in *The Tea Quarterly*, Part I, 1940. There was a general desire for an increase in the work on Shot-hole Borer, and later the matter was considered by the Experimental Committee which passed the following resolution :—

"That through the agency of the District Planters' Associations, the Institute should be informed of those estates on which Shot-hole Borer was regarded as being the cause of serious crop losses, that the Institute should ask permission to investigate the records of those estates first of all in general by correspondence and questionnaire, and personally in detail, to ascertain the facts about crop losses."

Following this, District P.A.'s were requested to co-operate with the Institute in its programme.

The idea of investigating statistically records of crop and manuring programmes, together with any other material data to be found amongst estate records, as one method of approach to the investigation of Shot-hole Borer damage, was not reached quickly, but has been maturing for

some time. To say that structural damage and deterioration is an entirely separate problem, also awaiting investigation is to misunderstand the scope of the enquiry. It is well known that crop shows a rise or fall from year to year, and that it is impossible to say exactly how this is caused, although it seems to be related mainly to weather conditions. But careful examination of various factors over many years should reveal tendencies to repression or augmentation of crop apart from the play of the weather. Deterioration of bushes must eventually reveal crop depression, and this may be masked by replanting, but each of these factors if registered will supply answers which go to make up the composite picture which is sought. Effects of manuring, resting and other activities will also be revealed. It is most important to reduce all these factors to a form in which they can be handled in order to get a concrete picture, as opposed to the formulation of opinions unsupported by evidence; and hence the request for co-operation by estates which consider Shot-hole Borer a serious pest.

Hard and Light Plucking Experiment.—Reference was made in the report for 1939 to an experiment which was being carried out at Passara to test an opinion, popularly held among planting circles, that hard plucking induces a heavier infestation by Shot-hole Borer than light plucking. The experiment was laid out in a field with a two-year cycle—at an elevation of 3,500 feet—and one reputed always to harbour the borer. Three plots, each consisting of 200 bushes, were allotted to each type of plucking. The field was pruned in November, 1938, manured in March, 1939, and first plucked in May, 1939. The total leaf taken under each type of plucking up to the end of November, 1940 was as follows :—

“Hard” Plucking = 1,246.70 lbs.

“Light” Plucking = 1,007.16 „

15 examinations for the incidence of borer were made in 1940 and spread over a period of 10 months. The bushes examined (they were pruned and brought to the laboratory for careful examination) were therefore, one to two years old. The following is a summary of data gathered :—

Total branches examined		Percentage affected branches		Average No. of galleries per affected branch		Mean content per occupied gallery	
Hard	Light	Hard	Light	Hard	Light	Hard	Light
10,943	10,863	11.18	14.68	1.41	1.50	6.46	5.31

The above would indicate that light plucking and not hard plucking had the greater percentage of affected branches, though larger populations were found in the bushes that were plucked hard.

Since the field in which this experiment is being carried out is now to go through a 3-year pruning cycle (it was originally on a 2-year cycle), a final examination will take place towards the end of 1941.

Alternate Hosts.—Till a more comprehensive report can be submitted on this phase of the investigation the results hitherto obtained might be briefly tabulated as follows :—

1. Plants or trees in which the tea beetle *Xyleborus fornicator* succeeded in breeding i.e., raising a population : *Mimosa bracaatinga*.

2. Plants or trees in which beetles bored galleries only :—

<i>Acacia decurrens</i>	<i>Grevillea robusta</i>
<i>Achania</i> sp.	<i>Hevea brasiliensis</i>
<i>Albizzia falcata</i> (moluccana)	<i>Hibiscus rosa-sinensis</i>
<i>Cassia</i> sp.	<i>Lantana aculeata</i>
<i>Citrus sinensis</i>	<i>Psidium guajava</i>
<i>Crotalaria usaramoensis</i>	<i>Ricinus communis</i>
<i>Erythrina lithosperma</i>	<i>Spathodea campanulata</i>
<i>Gliricidia sepium</i>	<i>Tephrosia candida</i>
	<i>Tephrosia vogelii</i>

3. Tree which it failed to attack :—

Cedrela toona

Similar experiments carried out with the beetle, *Xyleborus fornicatus* from castor, however, indicated that this beetle is able to breed in at least 5 hosts in addition to castor, viz :—

<i>Albizzia falcata</i>	<i>Mimosa bracaatinga</i>
<i>Hevea brasiliensis</i>	<i>Tephrosia candida</i>
	<i>Thea sinensis</i>

The following trees and shrubs contained entrance holes and comparatively short galleries :—

<i>Acacia decurrens</i>	<i>Gliricidia sepium</i>
<i>Achania</i> sp.	<i>Grevillea robusta</i>
<i>Cedrela toona</i>	<i>Hibiscus rosa-sinensis</i>
<i>Citrus sinensis</i>	<i>Lantana aculeata</i>
<i>Crotalaria usaramoensis</i>	<i>Psidium guajava</i>
<i>Erythrina lithosperma</i>	<i>Spathodea campanulata</i>
	<i>Tephrosia vogelii</i>

Regarding Castor, (*Ricinus communis*) it would appear that this host is not susceptible to attack by borer (*Xyleborus fornicatus*) till the tree is at least two years old. As there is now some doubt as to whether the trees used for the experiment with *X. fornicator* from tea were of a suitable age to harbour beetles, the test with castor is being repeated.

Loss of Crop Experiment.—As a preliminary to initiating an experiment to determine loss of crop caused by Shot-hole Borer, a small experiment was started early in 1939 to ascertain the number of branches damaged

by borer during a complete cycle. A field on Gonakelle, at an elevation of 3,500 feet, and one recommended by the Manager as being susceptible to Shot-hole Borer attack, was chosen. A hundred bushes were selected and each bush numbered. At each plucking a careful record was made of the number of branches damaged. The following table is a summary of observation recorded from May, 1939 when the field came into plucking—to November, 1940:—

	May, 1939 to May, 1940	June, 1940 to Nov., 1940	May, 1939 to Nov., 1940
No. of plucking rounds	54	22	76
Occasions on which damaged branches were found	13	16	29
No. of branches damaged	27	441	468
No. of bushes damaged	20	88	88
No. of bushes free of damage	80	12	12

The above figures indicate that by far the greatest amount of damage was sustained towards the end of the pruning cycle.

The next stage in the experiment is to find out how much crop may be lost by branches broken off. This is in progress and will be completed during 1941.

Shot-hole Borer and Pruning.—It has been suggested that it is difficult to prune a Shot-hole Borer field owing to the fact that branches break off in the hand at weak spots during the operation, resulting in bad frames. To ascertain how far this is true observations were carried out on an estate in the Balangoda district, elevation 1,500 feet, in a field with an 18-month pruning cycle. Two pruners were followed while 500 bushes were pruned and relative data recorded in the field. The following is a brief summary of some of the data collected relative to damage caused below the pruning level.

Number of bushes damaged	...	...	181
Number of branches damaged from all causes	...	...	274
Damage at fracture due to			
i. Shot-hole Borer and woodrot	...	...	145
ii. Shot-hole Borer alone	...	...	118
iii. Woodrot alone	...	...	9
iv. Neither cause	...	...	2

Of the 274 branches broken :—

224 were less than $\frac{1}{2}$ in. thick.

200 were less than 6 in. below pruning level.

92 of these were in old wood, of which 51 were less than $\frac{1}{2}$ in. thick.

22 of the branches broken were in old wood more than 6 in. below pruning level, and more than $\frac{1}{2}$ in. thick.

19 branches of new wood were broken below this level, of which 1 exceeded $\frac{1}{2}$ in.

Generally speaking, the bushes were large and well grown, and the damage caused to frames by breakage below pruning level did not appear to be of a serious nature.

Nettle Grub.—1940 saw a rise in both the number of outbreaks and acreages attacked in Uva, and the Passara district was once again the chief locality to suffer the worst attacks. The number of estates affected (as reported to the T.R.I.) was 21 and these were distributed as follows : 10 from the Badulla district, 7 round Passara, 3 from Madulsima and 1 from the Haputale district. Of these 21 estates, one had the pest right through the year, two for 10 months, one for 9 months, and five for only one month each. The remaining twelve estates experienced outbreaks ranging from periods of 2 to 6 months each.

The average acreage attacked per month for the whole province was 658—the highest since 1934 when 773 acres were reported.

Control measures consisted in the collection of larvae and cocoons, spraying with soap and water when attacks were severe and pruning, in one instance, when the attack was too wide to be checked by any other measure. A feature of the outbreaks was the request from estates for local parasites.

Early in the year when it was anticipated that 1940 would see a recrudescence of the pest, a series of demonstrations was arranged at the Passara Sub-Station, with the co-operation of the Uva Planters' Association, for the benefit of Assistant Superintendents who were not familiar with Nettle Grub.

Three tables are attached : I. Nettle Grub situation in 1940.

II. Nettle Grub situation in 1931-1940.

III. Summary of returns for 1940.

Red Ants in Tea.—Further enquiries relating to this pest were received from low-country estates during the year. Attention is directed to the note in the Annual Report for 1939. (T.R.I., Bulletin No. 21, p. 42),

Tea Leaf-Miner.—From time to time this insect appears in large numbers, laying its eggs under the epidermis of the upper surface of the leaf. The larva lives under this layer, feeding on the soft green parts, and producing a blistered appearance on the leaf.

This insect has for long been known as *Oscinis theae*, although it clearly belongs to a different family from that implied (*Oscinidae*). Its correct name is a species of *Melanagromyza*, belonging to the family *Agromyzidae*, in which family Green ("Insect Pests of the Tea Plant," 1891) originally placed it. This determination comes from the British Museum.

Madasumma marginipennis Guer.—This cricket was reared from eggs laid in a tea stem about 5 mm. thick. They were all lodged in the pith. Several were parasitised by an unidentified parasite of the family *Encyrtidae*.

The eggs took at least 2 months to hatch, and the only two which were reared to maturity took about 4 months to do so; both were females.

The crickets refused to feed on tea, but did so on bean and Dadap leaves.

C. B. REDMAN KING,
Entomologist.

TABLE I
SUMMARY OF NETTLE GRUB OUTBREAKS IN UVA 1940.

1940	Badulla District*				Passara District				Other Districts **				Whole of Uva			% Acreage affected
	Estates affected	Out-breaks	Acreage attacked		Estates affected	Out-breaks	Acreage attacked		Estates affected	Out-breaks	Acreage attacked		Estates affected	Out-breaks	Acreage attacked	
January	2	2	214		3	3	113		1	1	100		6	6	427	0.58
February	2	2	45		3	6	396		2	2	95		7	10	536	0.73
March	4	6	175		5	12	463		1	1	39		10	19	677	0.92
April	4	4	455		4	8	655		1	1	39		9	13	1,149	1.56
May	4	4	259		6	12	522		—	—	—		10	16	781	1.06
June	4	4	295		5	9	587		1	1	39		10	14	921	1.25
July	2	2	284		4	6	457		1	1	2		7	9	743	1.01
August	4	5	268		4	6	193		—	—	—		8	11	461	0.62
September	5	8	546		3	8	313		—	—	—		11	16	859	1.16
October	2	5	454		3	4	180		—	—	—		5	9	634	0.86
November	3	5	145		3	3	352		1	1	1		7	9	498	0.67
December	2	2	26		4	4	180		—	—	—		6	6	206	0.28

* Includes Namunukula

** Includes Haputale, Madulsima and Lunugala Districts.

TABLE II—NETTLE GRUB IN UVA, 1931—1940.

Planting District	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
Badulla										
Average No. of Outbreaks per month	7.5	5.3	6.6	5.0	3.5	4.0	3.9	2.5	2.8	4.1
" " acreage affected	373	439	333	217	143	236	176	61	148	264
Percentage (acreage) infection per month	1.14	1.33	1.00	0.65	0.43	0.71	0.53	0.19	0.47	0.83
Passara										
Average No. of Outbreaks per month	7.0	4.0	4.5	7.5	9.0	4.4	4.8	2.8	2.8	6.8
" " acreage affected	727	390	250	251	229	210	222	94	101	368
Percentage (acreage) infection per month	7.42	3.98	2.54	2.55	2.32	2.13	2.30	1.00	1.07	3.90
Haputale and Haputale West										
Average No. of Outbreaks per month	2.20	1.0	0.5	0.2	0.25	0.5	1.0	0.09	0.08	0.08
" " acreage affected	180	46	22	—	75	6	11	5	3	2
Percentage (acreage) infection per month	0.74	0.18	0.09	0.2	0.29	0.02	0.04	0.02	0.01	0.01
Madulsima and Lunugala										
Average No. of Outbreaks per month	2.0	0.2	1.0	0.5	0.5	0.58	0.25	0.58	—	0.5
" " acreage affected	101	1	43	5	5	24	2	2	—	25
Percentage (acreage) infection per month	1.01	0.01	0.43	0.06	0.05	0.24	0.02	0.02	—	0.24
Uva										
Average No. of Outbreaks per month	18.5	10.7	12.5	13.0	10.0	9.5	9.9	6.0	5.6	11.5
" " acreage affected	1381	876	648	773	384	475	411	162	252	658
Percentage (acreage) infection per month	1.77	1.12	0.81	0.98	0.49	0.60	0.52	0.22	0.34	0.89

TABLE III.—NETTLE GRUB RETURNS—1940.

Planting District	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
BADULLA												
46 estates supplied with cards. No. of estates which sent in returns	22	20	22	22	21	20	22	20	23	20	20	20
" " declared free of pest	20	18	18	18	17	16	20	16	18	18	17	18
" " reported outbreaks	2	2	4	4	4	4	2	4	5	2	3	2
Total acreage affected	214	45	175	455	259	295	284	268	546	454	145	26
PASSARA												
9 estates supplied with cards. No. of estates which sent in returns	8	8	8	8	8	8	7	8	8	7	7	8
" " declared free of pest	5	5	3	4	2	3	3	4	2	4	4	4
" " reported outbreaks	3	3	5	4	6	5	4	4	6	3	3	4
Total acreage affected	113	396	463	655	522	587	457	193	313	180	352	180
MADULSIMA												
(Including Lunugala)												
14 estates supplied with cards. No. of estates which sent in returns	8	8	8	6	7	6	7	6	7	6	7	8
" " declared free of pest	7	7	7	5	7	5	6	6	7	6	6	8
" " reported outbreaks	1	1	1	1	—	1	1	—	—	—	1	—
Total acreage affected	100	75	39	39	—	39	2	—	—	—	1	—
HAPUTALE												
(Including West Haputale)												
42 estates supplied with cards. No. of estates which sent in returns	15	13	11	12	13	12	11	13	12	11	11	14
" " declared free of pest	15	12	11	12	13	12	11	13	12	11	11	14
" " reported outbreaks	—	1	—	—	—	—	—	—	—	—	—	—
Total acreage affected	—	20	—	—	—	—	—	—	—	—	—	—
UVA												
(Above districts only)												
111 estates supplied with cards. No. of estates which sent in returns	53	49	49	48	49	46	47	47	50	44	45	50
" " declared free of pest	47	42	39	39	39	36	40	39	39	39	38	44
" " reported outbreaks	6	7	10	9	10	10	7	8	11	5	7	6
Total acreage affected	427	536	677	1149	781	921	743	461	859	634	498	206
Percentage (acreage) infection per month	0.58	0.73	0.92	1.56	1.06	1.25	1.01	0.62	1.16	0.86	0.67	0.28

REPORT

OF

THE AGRICULTURAL CHEMIST

FOR 1940.

Staff.—The Agricultural Chemist has remained in charge of the investigations of the Department of Plant Physiology. There have been no changes in the staff.

Advisory.—523 letters were received and 464 replies were despatched. The main theme of advisory correspondence has been manuring in relation to the changing circumstances of supply. The informal conferences on fertilizer supplies have been a great help in keeping in touch with the situation, and the agreed scheme of distribution has worked smoothly. Judging from our correspondence, which we believe emanates from a fair cross-section of the industry, there has been very little decrease in the manuring of tea. The nitrogen position, which is of the utmost importance, has been relieved by the availability of supplies of nitrate of soda and groundnut cake. The price of the latter has decreased, presumably because, owing to non-shipment to European markets, a more than ample supply is obtainable. Both these fertilizers are higher in unit price than sulphate of ammonia but the difference has not up to the present been serious. Since the middle of the year it has become necessary to ration potash manures. It is possible that supplies may eventually be exhausted. The evidence of the field experiments at St. Coombs and Passara indicates that if a cessation of potash manuring becomes inevitable, the health of the tea plant will not be damaged over such a period of time as it may be reasonably expected shortage will last. Indirect confirmation of this arises from the researches on potash deficiency in Java. A note on this work appeared in *The Tea Quarterly*, Vol. XIII, Part 4.

In regard to the future, the exhaustion of supplies of sulphate of ammonia even though rationing has been adopted, will throw consumers back onto nitrate of soda and organic nitrogenous fertilisers, notably groundnut cake. This will cause a further increase in the cost of manuring. Allowing an average consumption of 45 lbs. of nitrogen per acre

per annum this price increase may amount to Rs. 5 or Rs. 6 per acre. Nevertheless, since the results of manurial deficiency are felt over a longer period than that covered by stoppage or diminished doses, it will be in the interests of estates to continue normal manuring for as long as possible.

Lectures.—At the first delegate Sub-Conference held in March, the Agricultural Chemist took part in a comprehensive discussion on the subject of manuring in war-time.

Publications.—"The Effect of Narrow Carbon-Nitrogen Ratio and of naturally occurring Tannins in Decomposing Plant Materials upon the Production of Mucus." J. G. Shrikhande, *Soil Science*, 1940, Vol. 49, pp. 1-8.

"Estimation of Lignin in Tannin Materials." J. G. Shrikhande, *Biochemical Journal*, 1940, Vol. XXXIV, pp. 783-789.

INVESTIGATIONS IN PROGRESS.

The division of the time of the senior officer between two departments has reduced somewhat the volume of research in each individual department. The year has been occupied mainly in consolidating existing lines of research and in preparing for new ones.

Decomposition of Vegetable Materials.—The work on the decomposition of vegetable material, which had its origin in the compost controversy, has become of less urgency. But in the course of that work a number of technical points arose which showed that materials containing tannin did not behave exactly like ordinary green manures. Dr. Shrikhande, whose special province this was, has spent a large part of his time in rounding-off his investigations on these points. Work of the kind that has been reported in previous bulletins involves a comprehensive series of analyses from which a picture of the broad outline of the dynamic process of decomposition can be drawn. The chemical methods by which these analyses are conducted were originally worked out for the plant materials common in temperate agriculture, and it soon became evident that they were not altogether satisfactory for an exotic species such as tea. In order therefore that the analyses used for our interpretation of the decomposition phenomena might be reliable, a number of these methods have had to be reconsidered. The proper place for the discussion of these methods is a scientific or technical journal, and, as shown above, contributions on tannin interference have been made from this department in such journals. These investigations, which have led to the modification of existing analytical methods, are of too specialist a nature to be reported here. They have ensured that in future researches, we shall have at our disposal adequate technical means on which to base our agricultural conclusions.

Foliar Diagnosis.—From time to time in advisory correspondence, the question arises whether routine analysis particularly of soils, is a fair basis for cultural and manurial recommendations. The view has more than once been expressed in our publications that, except under special circumstances, routine analyses contribute little information on nutritional requirements. It has always been our opinion that to give precision to the interpretation of routine analyses it is necessary that the analytical work should, in the first place, be conducted in close co-operation with field trials made under known conditions, and closely controlled. The Institute's major manurial trial has now entered its tenth year. During that period the field details of manuring and crop response are available. Deficiencies are already apparent or becoming so in some treatments, and the time is accordingly ripe for analytical work that will help to define deficiency limits. When this stage of the investigation is complete, the more general application of the results of data can be considered. During the past year work has been put in hand to gather information on the correlations between crop yield, plant composition and soil composition. This work is intended to cover the three main nutrient, nitrogen, potash and phosphate.

At the present time, only the plant analyses for nitrogen are completed. Table I gives the results for both pruning wood and pruning leaf classified according to the manurial treatment received.

Without proceeding to a detailed analysis of these figures it is possible to draw certain conclusions. Relationships are beginning to emerge between nitrogen content of the plant material and the cumulative manurial treatments with nitrogen and potash. As manuring with nitrogen increases in intensity so does the nitrogen content of leaf and wood: as potash manuring is increased so the nitrogen content decreases. Notwithstanding this general effect there is some evidence that will need further confirmation, that the full effect of nitrogen manuring is not felt in the absence of some potash. In both materials at the no-potash level, the maximum value is reached at the mid-value for nitrogen manuring. At present a distinction must be drawn between the effects of potash and nitrogen severally or combined, and phosphate. There is no evidence in these figures that phosphate influences the nitrogen content of the plant material. The phosphate treatments were added to the experiment only in the second cycle. Their effect may develop later. On lines similar to those indicated the whole field of inter-relationship between soil treatment and foliar composition will be explored, with a view to determining how far the method of foliar diagnosis of deficiencies is applicable to the tea plant.

TABLE I
Effect of manurial treatment on nitrogen content. (Average of 6 plots).
Percentage Nitrogen in Dry Matter.

Pruning Leaf											
	K _O	K ₂ O	K ₄ O	Mean	P _O	P ₃ O	P ₆ O	Mean			
N. 40 lbs. per acre	2.29	2.22	2.22	2.24	2.24	2.27	2.21	2.24			
N. 60 "	2.42	2.30	2.27	2.33	2.38	2.28	2.33	2.33			
N. 80 "	2.38	2.42	2.38	2.39	2.38	2.38	2.42	2.39			
Mean	2.36	2.31	2.29	2.32	2.33	2.31	2.32	2.32			
Pruning Wood											
	K _O	K ₂ O	K ₄ O	Mean	P _O	P ₃ O	P ₆ O	Mean			
N. 40 lbs. per acre	0.71	0.69	0.69	0.65	0.69	0.71	0.69	0.65			
N. 60 "	0.74	0.73	0.66	0.71	0.74	0.69	0.72	0.72			
N. 80 "	0.74	0.74	0.74	0.74	0.74	0.76	0.72	0.74			
Mean	0.73	0.72	0.65	0.70	0.72	0.72	0.71	0.70			

Time of Application of Manures.—Progress reports have been given previously on the behaviour of the yields from the main manurial experiment. The completion of a third cycle has confirmed the former trends of the data regarding the effectiveness of nitrogen, and to a lesser degree of phosphate, and the absence of response to potash. Divided duties have prevented the full analysis of the results, which, however, will be published when completed. There are now available the results for the whole cycle showing the effect of delaying the initial dose of manure for three and six months respectively ; all other doses being applied at the normal intervals from pruning. In the table that follows the data show the cumulative increase in yield above the plots manured at pruning time

TABLE II

Effect on yield of delay in the application of first year manuring.
lbs. per acre.

Plucking	Applied 3 months after pruning		Applied 6 months after pruning	
	Cumulative increment	Difference	Cumulative increment	Difference.
5	1.9		1.0	
10	5.4	+3.5	3.8	+ 4.8
15	11.9	+6.5	13.6	+ 9.8
20	19.8	+7.9	24.5	+10.9
25*	28.0	+8.2	37.2	+12.7
30	32.0	+4.0	47.3	+10.1
35	35.4	+3.4	57.3	+10.0
40	39.0	+3.6	66.0	+ 8.7
45	43.5	+4.5	72.1	+ 6.1
50	45.7	+2.2	76.0	+ 3.9
55	47.5	+1.8	80.0	+ 4.0
60	47.6	+0.1	79.8	— 0.2
65**	46.7	—0.9	83.3	+ 3.5
70	45.0	—1.7	83.0	— 0.3
75	42.6	—2.4	89.6	+ 6.6
80	43.6	+1.0	93.6	+ 4.0
85	44.3	+0.7	100.9	+ 7.3
90	43.6	—0.7	104.6	+ 3.7
95	45.3	+1.7	107.5	+ 2.9

* Marks application of second dose to all plots.

** Marks application of third dose to all plots.

The data show that yield is increased by each delay in application and that roughly the increment obtained is proportional to the time that elapses before manurial operations are undertaken. The column labelled 'difference' shows how these increments are distributed over the cycle. In both cases the further manuring at the time of the twenty-fifth plucking fails to obliterate the primary effect. The advantage of delay is carried forward into the new season, better use being made of the nutrient supplied later. In the three-month treatment this advantage disappears before the third manuring: positive values turn to negative with a certain amount of spasmodic reversal of effect. But in the six-month treatment the advantage is progressive throughout the whole cycle, with the exception of two insignificant negative values at the sixtieth and seventieth pluckings. Described in another way we may say that the time curve of the cumulative increments flattens out at the sixtieth plucking on the three-month plots, but continues to rise, though by decreasing amounts, right through the cycle in the case of six-month plots.

The Nitrogen Economy of Tea.—From the results so far obtained in this manurial investigation it is possible to construct a picture of the physiological progresses that account for them. A brief description of some of these was given in last year's report. It appears more and more probable that when nitrogen is applied to tea the plant undergoes a period of luxury consumption and absorbs and synthesizes into storage products a great deal more nitrogen than it can use in the immediate future. It is probable indeed that the fine network of feeding roots in good mature tea absorbs the bulk of the available nitrogen almost immediately it is applied, and that when climatic conditions are optimal the stored reserves are drawn upon immediately and rapidly to provide the rushes of growth which are a familiar feature of tea flushing periods. This view is supported by two independent pieces of evidence. A detailed examination of the response to nitrogenous manuring during nine years has shown that the intensity of that response is greatest during the rainy period of the South West Monsoon. This is a period when the nitrate content of the soils is adversely affected by severe and continuous leaching. It is hardly conceivable that the intensified response to nitrogen at this time can be due to the immediate foraging activity of the roots for the added nutrient. It has been observed that this result is obtained as late as ten months after pruning.

Table III summarises data taken from the first and second cycles of the experiment. In the first cycle the manuring date was November and in the second April. The results refer to the third year in each case so that pruning date causes no interference with the interpretation.

TABLE III

Response to nitrogen in relation to time of manuring and seasonal weather conditions.

First cycle.

	Present response	Months after manuring	Date
Lowest response	12.5	1	December 1932.
Highest „	53.3	10	August 1932.

Second cycle.

Lowest response	16.7	1	May 1936.
Highest „	73.2	4	August 1936.

The second piece of evidence is that provided by the stability of the ratio between nitrogen added and the crop produced. Again it is hardly conceivable that if the absorption of added nitrogen was protracted and piecemeal, and was at the mercy of the variable leaching caused by variable seasons, a steady ratio of efficiency would be maintained in seasons of very different rainfalls. Actually such variation as has been observed has been unfavourable only in years of severe drought such as 1938 and 1939 when the limiting factor was not manurial loss. In brief, the indications are that tea absorbs available nitrogen quickly and in bulk, synthesizes it to compounds of greater complexity and stores it, and does this only when the foliage cover is well developed.

What then of the period immediately following clean-pruning? Our results are concordant with the view that in a leafless condition the bush absorbs little nitrogen. Data have been reported previously to show that whatever nitrogen is absorbed in this early stage produces no effect before tipping operations five months later. Past results also show that normally we can count on a marked response to nitrogenous manuring within two to three months. These observations discount the suggestion that any considerable amount of nitrogen applied at pruning time is immediately put at the disposal of the plant. There is a further observation, the validity of which has been appreciated for many years, which suggests that under normal conditions a pruned bush is not deficient in nitrogen to an extent that will interfere with its immediate development. This observation is linked with the condition that used to be described as *Diplodia* disease. The researches of Dr. Gadd, supplemented by those of Dr. Tubbs, showed that the death of bushes after pruning was due not to a parasitic invasion but to food-reserve shortage. Furthermore that shortage was traced to one class of material, carbohydrates, which are devoid of nitrogen. It is a fact within the knowledge of all who have experienced the disease to

a greater or less extent, that the application of nitrogen at the time of pruning has done nothing to check the incidence of the malady. The justifiable conclusion is that in general, even under very diverse conditions, the pruned bush has enough stored nitrogen to balance its carbohydrate supply and thus to start that chain of operations which nourishes the growing points and promotes recovery from pruning.

There remains one possibility to be discussed. It is the possibility that the delay in nitrogenous manuring in the first year will adversely affect the growth of wood throughout the whole cycle notwithstanding the effect of subsequent manuring. We have already seen that crop is not adversely affected. At the end of the cycle the pruning wood was weighed with the results shown in Table IV.

TABLE IV

Effect of delayed first year manuring on wood growth.

Time of application	Lb. per acre pruned wood.	Per cent.
At pruning	647	102
3-month delay	628	99
6-month delay	628	99

The 3 per cent difference in favour of manuring at pruning time is only a fraction of that required for statistical significance. Despite all precautions and technical ingenuity, no field experiment with tea has ever given an accuracy that would define a difference between treatments so low as this, as due to anything but pure chance. Were the figures viewed merely subjectively the plausibility of the difference between application at pruning time and later would still be gravely upset by the fact that there is no difference between the two delayed doses.

All these trains of evidence converge on the same point and support the hypothesis that manuring with nitrogen at pruning time is less efficient than when the bush has developed a cover of foliage. This hypothesis, as has been seen, does no violence to current physiological conceptions.

Experiment on Manuring Cycle.—Some years ago in advisory work use was made of the relationship between nitrogen applied and crop produced to develop the conceptions of what were called the nitrogen and residual equivalent of yield. (*The Tea Quarterly* 1938, Vol. XI, p. 24) The indications given by the application of this method were that in many cases, manurial programmes were unnecessarily wasteful in the last few months of the pruning cycle. During the past year an experiment has been started to give experimental precision to the problem of the best disposal of manurial quantities during the pruning cycle. A

little calculation shows that for a three-year pruning cycle using three different doses of nitrogen arranged in as many different sequences as possible within the years, no fewer than twenty-seven combinations would be needed. Apart from the technical difficulties of such a large experiment replicated to the necessary extent, there is no practical need for such a degree of complication. Using the experience gained in former work a small experiment has been designed in which the treatment sequences are as follows :—

TABLE V

Treatment for Fertilizer Cycle Experiment.
Quantities of nitrogen (Pounds per acre).

Treatment No.	First year	Second year	Third year.
1	30	30	30
2	30	45	30
3	30	60	30
4	30	30	45
5	30	45	45
6	30	60	45
7	30	30	60
8	30	45	60
9	30	60	60

In the first year a standard dose has been given: there seemed little point in giving at that time of relative immaturity of the plucking table high doses to be followed by smaller ones. The first dose is given six months after pruning, and the rest of the cycle is divided into three equal periods of ten months. The experiment should give a considerable amount of valuable information about the cumulative effect of manuring. By way of example we may consider the comparison of treatments 6 and 8. Both are alike in total quantity supplied in the cycle. Is it possible that the total effectiveness of the 60-lb. dose will be greater if supplied earlier in the cycle?

In this experiment the opportunity has been taken to study the use of nitrate of soda as a nitrogenous fertilizer. One-third of the whole number of plots is manured with this material; one-third is given an equivalent amount of sulphate of ammonia; and the remaining third receives its nitrogen half in the form of nitrate of soda and half as sulphate of ammonia. The experiment is now due for its second manurial application, which marks the start of the quantitative variation. The results of the applications of qualitatively different nitrogenous mixtures show no significant differences so far.

Food Production.—In the annual report for 1939 small scale nursery trials were reported on five cereals and two legumes. Of these only Bullrush Millet (*Penisetum glaucum*) matured in a reasonably normal time and produced grain, which ripened unevenly between four and six months. Adlay (*Coix lachryma-jobi*) produced grain only after an interval of 12 months. None of the other species produced a crop. Bullrush Millet was therefore left as the sole possible cereal.

It was proposed that the two acres of patna land opened for the larger trials should be worked on a rotation of roots, legumes and cereals. The stand of maana grass was sickled, forked in and contour bunds of sod were made to protect the land from erosion. These were further protected with stone and planted with Guatemala grass (*Tripsacum laxum*) to bind them, and provide a wind break. The land was given a dressing of 25 tons of well-made compost.

On the one acre of root land three varieties of sweet potato from Peradeniya were grown, Nos. 47, 54 and 219. Only one, No. 54, showed signs of rapid establishment and even that did not grow subsequently with real vigour. The other acre was planted with bush lima bean. The climbing variety grows well in St Coombs gardens. The beans germinated favourably in good weather, but have remained stunted and have flowered when only 9 to 12 ins. in height. It is doubtful whether a crop will be secured.

Success has been prevented by several factors. The patna soil is poor; the deprivations of insect larvae have been severe; the deprivations of human beings have been most severe of all. The cost of a watcher is prohibitive and probably useless.

The conclusions to be drawn from the trials are clear: The production of annual crops, which, above all others, require an equable climate and adequate nutrition during the short critical period of vegetative growth, is impossible except on land in a condition of high farming. This is in accordance with experience elsewhere in the tropics as well as at home. Such conditions do not and cannot apply to any appreciable acreage of land available on estates.

T. EDEN,
Agricultural Chemist.

REPORT

OF

THE PLANT PHYSIOLOGIST

FOR 1940.

Staff.—The Agricultural Chemist has remained in charge of the investigations of the Plant Physiological Department throughout the year. The continuation of the work of the department has been greatly helped by the voluntary assistance of Mrs. T. E. T. Bond, M.Sc. Mrs. Bond is a graduate in Horticulture of the University of Reading and a former member of the staff of the Long Ashton Agricultural and Horticultural Research Station in the University of Bristol. It is a pleasure to record the department's thanks for the constant assistance Mrs. Bond has rendered which has enabled a larger programme to be maintained than would otherwise have been possible.

INVESTIGATIONS IN PROGRESS.

(1) Propagation of Cuttings.

The research of the department has centred almost entirely round selection and vegetative propagation of selected material. As was mentioned in the previous year's report the raising of mature plants from cuttings presents various difficulties if a consistently high percentage of successes is to be achieved. A survey of the batches of cuttings made prior to the year under report showed very marked variation in the degree of rooting attained. Occasionally a high percentage was reached, but with other batches under conditions as similar as it was possible to reproduce, the results were poor. The average performance was only 35 per cent. Further losses were caused by transference to the field or even to ordinary supply baskets, and even those plants which continue to live show a marked reluctance to grow. It therefore appeared desirable to explore in detail the technique of propagation so that when

selected material was ready for multiplication a proved successful technique should be available. The two most important points were:—

- (1) How to increase the percentage of rooting and to shorten the time needed.
- (2) How to overcome the losses on transference and to shorten the period of dormancy.

In order to get fuller knowledge of the causes of failure a log has been kept of the behaviour of every individual cuttings. In particular the following observations have been made:—

- (1) Loss of old leaf.
- (2) Death or blotching of leaf by invading saprophytic fungi.
- (3) Development of the bud in the leaf axil.
- (4) Callus formation at the exposed end of the cutting.
- (5) Callus formation at the end embedded in the medium.

Some of the observations made have special reference to the conditions under which the various experiments have been carried out and will be mentioned later. Two factors are of more general interest and will be dealt with first.

Effect of Light.—When a cutting is placed in the rooting medium it has a considerable leaf area, from which it readily loses moisture by transpiration, but no roots. It is therefore necessary to maintain a high humidity as a counter-measure. Direct sunlight heats the leaf surface sufficiently to cause scorch which is followed by death. On the other hand it is necessary that an adequate degree of illumination should be given. On this illumination depends the production of elaborated food material from the atmosphere, upon which, in turn, growth of roots will depend since the reserves already in the cutting are strictly limited. When rooting is carried out in boxes or cold frames, cuttings near the sides are subject to shading and it has been consistently noted that a large percentage of deaths occur in cuttings so situated. As a result recent trials have been carried out under high shade provided by an open thatched shed 10 ft. high at the ridge and 6 ft. high at the eaves and this has proved satisfactory.

Of considerable promise from a practical point of view is a trial in which the cuttings were planted in a prepared bed with only a heavy fern shade. As this thinned when the fern dried, a further addition was made. These cuttings were allowed to remain in position for four months and were watered as necessity arose. Out of 200 planted, 156 survived and

138 developed vigorous roots. This represents 69 per cent success. The period of test extended from June 29th to November 1st when the weather conditions were favourable. It is proposed to repeat the trial under conditions of stronger insolation and drier atmosphere.

Moisture Content of Medium.—Where frames covered with glass lights were used, only occasional watering was necessary. The period between waterings varied from a few days to two months. It was found convenient to place the rooting medium on top of a three-inch layer of sifted cinders or small road metal in order to give adequate drainage, and then to soak the medium leaving it to drain to a natural optimum.

Type of Medium.—The use of peat-moss has been recommended as advantageous for rooting because of its high water-holding capacity. The stocks of peat are exhausted, and replacement will be impossible. Several other media and combinations of media have been tried. In the first trial peat alone was tested against equal portions of soil and peat, and equal portions of peat and sand. In the second experiment mixtures including sand and soil and peat were used. The percentage rooting is given in Table I:—

TABLE I
Influence of Medium on Rooting of Cuttings

Percentage Rooted.

	1st trial (10 weeks)	2nd trial (14 weeks)
Peat	34.4	
Peat : Sand (1 : 1)	24.0	
Peat : Soil (1 : 1)	56.8	56.0
Peat : Sand : Soil (1 : 1 : 1)		56.0
Soil		68.0

There is no direct comparison between the two experiments but the indications are clear. In the first experiment the addition of sand proved disadvantageous; the addition of soil was beneficial. The differences tabulated are statistically reliable. In the second experiment the soil appears to be the best medium, but the experimental accuracy is not sufficient to make this more than probable. Nevertheless it is evident that, taking the two trials together, the determining factor in the promotion of good rooting is the addition of soil.

The effect of the medium is not merely quantitative; the type of rooting is also affected. The presence of sand encourages the callusing of the lower end of the cutting at the expense of rooting. In addition the root systems of cuttings embedded in peat or peat and sand are less branched, and the individual roots are thicker and more brittle than when soil is a component of the rooting medium.

At present it would be premature to recommend the exclusive use of soil, because in drier weather the presence of peat may be an advantage in maintaining equable moisture relations and a suitable texture in the medium under conditions of frequent watering. But in view of these results further trials are in progress, and it is proposed to test coir dust in place of peat.

Type of Cutting.—Since the activity and survival of a cutting depends upon its capacity to provide food materials for the growth of roots, the two outstanding points in connection with type of cutting used are the number of leaves retained and the age of the leaf and wood that comprise each cutting. On the former question two separate trials have shown that the single node cutting is superior to the double node, which is in turn better than a cutting with three nodes bearing leaves. The average percentage out-turn of rooted cuttings at the end of two-and-a-half months was as follows:—

TABLE II
Percentage of Rooted Cuttings at 2½ Months

Single leaf	Double leaf	Treble leaf
51	45	17

The findings for age of cuttings are not so clear. For the purpose of the experiments the classification adopted has been that of division into green-wood and red-wood cuttings. In the first experiment carried out the red-wood showed a superiority in the number rooting which cannot however be regarded as sufficiently reliable to establish the point. On the other hand a set of cuttings all taken from the same bush showed a marked superiority in favour of red-wood though the average performance was poor. There is at present no basis for inferring that in general red-wood cuttings are best, though this may turn out to be the case on further examination. The manner in which the question was asked was not precise enough. The most probable explanation of these differing results is that a green-wood cutting from one bush is not necessarily worse than a red-wood from a totally different bush. The mixed population of bushes from which the material was drawn would in such a case

confuse the point at issue. With cuttings from a single bush no such confusion arises. Since the object of the vegetative propagation work is to produce clones, a further exploration of the behaviour of individual bushes in this matter is needed.

The intensity of the effect which *may* be produced is shown in the figures in Table III:—

TABLE III
Rooting Capacity of Green and Red-wood Cuttings
from a Single Bush

	Red-wood	Green-wood
Percentage Rooting (5½ months)	22.9	4.3

GROWTH-REGULATING SUBSTANCES.

In the Annual Report for 1938 trials were reported using three preparations that have been found with other plants to have the effect of stimulating the formation of roots. The results of the trials reported were inconclusive. Two of the preparations gave no results in terms of increasing percentage of cuttings rooted. The third, at one concentration only, gave a small but statistically reliable difference (11 per cent). No general conclusions in favour of the use of such substances were drawn. In the course of the year a trial has been given to a different but allied substance.

It is a matter of experience in the use of these growth-regulating substances that if high concentrations are used they defeat the ends in view because they kill the tissues from which the roots (if any) must spring. The experiment under report explored two concentrations; the one recommended by the makers, and double that strength. In addition following a suggestion that risks of damage to tissue might be less if the cut surface was callused before application of the growth substance, half the cuttings were allowed to form this protective covering before immersion in the solution. Different times of immersion were also tried.

The plan of the experiment is of some importance in view of the interpretation that follows, and must therefore be dealt with in rather more detail. All the cuttings were taken at the same time and half were embedded in a mixture of peat and sand known previously to be conducive to callus formation. They remained a month in that medium and were then removed and treated with the growth-substance *Hortomone A*. After treatment they were planted in a mixture of soil and peat. The remaining half of the original cuttings was immersed immediately

in the Hortomone A solution, and then transferred to soil peat and left undisturbed for a month. The two sections of the experiment were then amalgamated and left for another month in soil and peat before examination. In the experiment as finally set up at the end of the first month there were no rooted cuttings.

The results of the various treatments are tabulated in Table IV :—

TABLE IV
Effect on Rooting of Growth-substance and Pre-treatment

	At end of 2 months	Between second & third month	Total (3 months)
(a) <i>Percentage success</i>			
No treatment	30	35	65
Hortomone A. (Normal strength 1 part in 320)	48	27	75
Hortomone A. (Double strength)	62	22	84
(b)			
	Time of immersion in Hortomone A.		
	16 hours.	32 hours.	
Percentage rooted	70	79	
(c)			
	Previously callused	Not previously callused.	
Percentage rooted	88	71	

The figures plainly show how the growth-substance encourages a much more rapid root formation. At the end of two months there is a benefit of over 100 per cent when using the strongest solution of Hortomone A. During the ensuing month the order is reversed. Obviously this must be the case since the high percentage success initially achieved leaves fewer cuttings to develop roots. At the end of three months the Hortomone A is still ahead.

The longer time of immersion makes little difference, and the greater success is only probably significant. On the other hand the protective callusing treatment prior to application of the growth-substance is definitely an advantage, despite the fact that the subsequent time for root development is thereby reduced by a month. Taking the optimum combination of factors, *i.e.*, the strongest concentration of Hortomone for the longest time of immersion with a callused cutting, the percentage success reached the high figure of 97 per cent.

Foliage Development of Cuttings.—However much care is taken in the standardisation of cuttings some will have buds that are more active than others. What controls the activity cannot be stated, but since the first growth of both shoot and roots must obviously be made at the expense of the same food reserves and as a result of a limited photosynthetic activity in the parent leaf, it is of interest to know whether growth of shoots is antagonistic to that of roots. The individual records previously mentioned have enabled tests to be made of this point. The situation is, however, still far from clear. In the greater number of experiments so far carried out, root and shoot formation have been independent, whilst in a smaller number there has been a definitely established tendency (though not of a high order) for cuttings developing shoots to be slower in rooting.

TABLE V

Contingency of Shooting and Rooting

Numbers in each category (with theoretical values).

	Shot	Not Shot	
Routed	13 (24.2)	131 (119.8)	144
Not rooted	49 (37.8)	142 (153.2)	191
	62	273	335

In Table V the shoots from one experiment are classified in the four possible categories that concern shooting and rooting. The figures in italics under the experimental figures are the theoretical values that would be expected if shooting and rooting were independent. In the routed-and-shot class the theoretical figure is nearly twice that of the actual number found, and statistical analysis leaves no doubt that a discrepancy so large would only occur by chance about once in a thousand times. The observation does not appear at present to have any practical bearing on the technique of propagation but it is being followed up for its physiological interest. It is, however, interesting to note in this connection that the effect of the growth substance in promoting root formation was accompanied by a definite diminution in the formation of shoots from 34 to 21 per cent.

THE INCIDENCE OF CALLUSING AND ROOTING.

When cuttings are grown under similar conditions the early formation of callus on the top end is in general a good augury for subsequent rooting. But what happens at the embedded end is quite another matter. Some shoots make a large quantity of callus and throw out no root; others put out roots early without any evidence of callus formation; still others produce both. It has not so far been possible to sort out the general relationship between root formation and callusing at the lower end. The roots in nearly every case arise at the cut surface unless the tissues there have been damaged, as was the case in some of the Hortomone treatments.

There are, however, circumstances in which callus formation and root formation are antagonistic. Mention has been made of the special pre-treatment given to half the cutting in the Hortomone experiment. This was made possible by the discovery that a mixture of equal parts of sand and peat provided a medium specially favourable to callusing of the embedded end.

TABLE VI

**Percentages of Rooting and Callusing (at Proximal End)
for various media.**

	Peat	Peat-Sand (50:50)	Peat-Soil (50:50)
Rooted	34	24	57
Callused	35	69	32

The figures in Table VI show particularly the high degree of callusing and the low degree of rooting in a peat-sand-mixture. These figures merely give one aspect of the case. Not only did the peat-sand encourage callus formation on a large percentage of cuttings, but the mass of the callus formed was much greater than in the other media. Another aspect of the same problem is given in the experiment to which Table III relates. The rooting after so long a period is very poor, but the callusing was extraordinarily heavy, every cutting having its end completely covered with a large knob of callus.

BUD DORMANCY.

A high percentage of cuttings produce no shoots whilst in the rooting medium. On removal to supply baskets both these and those which have shown shoot-development remain stationary: some instead of making

vegetative growth form flowers. Examination of roots some time after transplanting, shows that a number of the newly formed roots die back and this would naturally retard growth. But the root dieback does not appear to explain the observed facts entirely. The protracted period of dormancy, sometimes extending for months, constitutes a problem as important as that of securing high rooting percentage, and work designed to clarify the position is in hand. The investigations are in too early a stage to report, but the question of variation of transplanting media, addition of nutrients, shade and illumination are all receiving attention.

Further investigations are in progress and upon their results will depend what technique is finally recommended as generally most successful for the propagation and subsequent rearing of cuttings. But though definitive methods cannot at present be given, there is enough data already in hand to encourage the hope that a method will in due course emerge which will not need special material nor buildings in order to secure a high percentage of success.

(II) SELECTION OF MATERIAL FOR PROPAGATION.

Selection of bushes in the field has continued during the year on the basis of individual yields over a period of forty plucking rounds. During the year further selections have been made from the two fields that had not been included in the programme when the last departmental report was made. These selections will be completed during the ensuing year, bringing the total number of bushes examined on St. Coombs to 2,762.

Of these selected bushes only a small percentage is retained as possible mother-bushes. Clones will be propagated and planted and tested amongst themselves in order to determine which owe their apparent superiority to the transmission of inherent characteristics and which to chance superiority in position and cultural treatment.

In addition to testing yield capacity, a start has been made by the Biochemical division to sort out those of consistently high quality. For details the report of that division should be consulted. Six sample-pluckings from every bush, spaced at intervals of approximately two months, are manufactured and reported on in the normal way. As a result many bushes which would be retained on the basis of their yield behaviour are discarded on account of poor quality.

Table VII shows the number of bushes tested in the various ways and gives an illustration of the severity of the criterion of rejection on which the selection work is based.

TABLE VII
Statistics of Bushes Chosen by Selection
for Yield and Quality

	1940	Previously	Total
Yield records completed	1007	1482	2489
Yield records till in progress	273		273
Manufacture tests completed (Number of bushes)	36		36
Manufacture tests in progress	30		30
Clones chosen on yield basis	93		93
Clones chosen on both yield and manufacture	8		8

T. EDEN,
Acting Plant Physiologist.

REPORT

OF

THE BIOCHEMIST

FOR 1940.

Staff.—There was no change in personnel. The steadily increasing demands on the Biochemist's time in connection with military duties has however entailed some reduction in the scope of his activities. These circumstances may also involve some modification in the future programme of work.

The work of the Department naturally depends to a large extent for its interpretation on the reports received on experimental samples from Colombo and London tasters. War conditions have made it impossible to continue our former tasting arrangements in London, and in Colombo it can hardly be expected that tasters, who are themselves working under exceptionally difficult circumstances, will be able to deal with the normal number of experimental samples.

Correspondence.—281 letters were received and 293 despatched. It will be noted there has been a considerable reduction in the advisory work carried out for estates, no doubt as a result of the conditions caused by the war. On the other hand many Agency Firms in Colombo have sought our advice on a variety of problems arising out of wartime restrictions of supplies. The greater number of these enquiries have been on the subject of materials for tea chests. Of the timber examined many have been of local origin. Investigations of local timber have also been carried out in conjunction with the Forestry Department.

To condense a long story it may be said that the greatest enemy of the local chest industry is the local maker who, anxious to take advantage of the prevailing relatively high value of tea chests, is unwilling to reject borer infested material. The presence of borer holes in the timber of tea chests, irrespective of whether the timber contains live borers or not, may cause whole consignments of tea to be rejected by countries such as Australia where vigorous methods are adopted to protect their own timber industry. The main source of infection in Ceylon is in the

log which is often left exposed to attack for many months after felling. When infection has taken place their rejection is the only possible course and it would appear that some centralised scheme for inspection of materials intended for export, or perhaps better still a system of reputable Trade Marks, offer solutions to these problems. Apart from the borer difficulties several timbers make excellent chests.

Tea chests linings have also been the subject of enquiry and many substitutes for lead and aluminium have been examined. Work arising out of wartime problems is likely to be an important feature of future activities.

ANALYTICAL.

92 determinations of moisture content were made for estates in various parts of the Island. 864 determinations were made for St. Coombs Estate. Samples of "Tea Crystals" manufactured in America were examined for the Tea Propaganda Board.

Various other materials including fuels and water samples were examined for various estates and firms.

BIOCHEMICAL.

Progress continues with the investigation of the enzymes of tea leaf. Three papers have been sent to Scientific Journals for publication. This work is of a highly technical nature but has practical bearings of the utmost importance.

Parallel work is proceeding at the Indian Tea Association's Station at Tocklai and we are keeping in touch with Dr. Houghton Roberts who is responsible for the work there.

It is a pleasure to record that although our views are by no means always identical, constructive criticism has in no way interrupted the friendly co-operation which has been established to our mutual benefit. During the coming year it is hoped that it will be found possible to publish a non-technical account of this work in *The Tea Quarterly*.

Publication of the technical details stage by stage would not, it is thought, prove of general interest to members who receive *The Tea Quarterly*.

GENERAL MANUFACTURE.

Firing Experiments.—The complete results of the experiments comparing firing at 160°F., 190°F. and 210°F. were reported in *The Tea Quarterly*, 1940, page 156. It was surprising how completely firing at

210°F. was condemned by Tasters in both Colombo and London. There is a prevalent idea that London Tasters rather like high fired teas but the idea has not found a scrap of support. The doubtful keeping quality of teas fired at 160°F. is disappointing since there is no doubt about their superiority when freshly fired.

However, the above article only reports investigations of single operation firing at 160°F. for periods varying from 21 minutes to 42 minutes in the drier. Investigations on firing to different moisture contents and on final firing are proceeding and will be reported shortly.

Firing in two operations is to be investigated as it is possible that if the first operation is carried out at 160°F., the second can be completed at 190°F. without detriment to quality but with beneficial effects upon keeping properties.

Rolling Experiments.—These experiments have been mainly concerned with batten effects and will be reported in *The Tea Quarterly* in detail.

The most striking point emerging is the very high proportion of rolling effect which takes place at the centre of the table. Battens on the outer part of roller tables are practically ineffective and it is hoped that we shall be able to use these facts to develop a type of rolling table superior to existing patterns.

Although under present conditions further experiments with the Clivemeare roller (on a commercial scale) are not practicable, results obtained with this machine have not been forgotten as the Clivemeare type of manufacture running to not more than three rolls has undoubted merits. Our experiments, during the past year in particular, have indicated the desirability of employing two types of roller during normal manufacture; one for twisting the leaf and "wringing" out the cell contents and the other for reducing the bulk when the first operation has been carried out. In previous reports of our rolling experiments it has been pointed out that once leaf has been broken up, further rolling is ineffective which means that the early twisting operation should not break up the leaf if the benefits of the twisting action are desired.

There is no apparent reason why twisting should take three or four operations of half-an-hour each to work the leaf into the desired condition and the subsequent cutting operations need not be prolonged. Roller tables and battens designed to give the maximum twisting or maximum cutting effect may therefore allow a more rapid completion of the rolling process with improvement in fermentation similar to the Clivemeare process and at the same time enable the orthodox appearance of the leaf to be retained.

Miscellaneous.—A further report on grading with stamped aluminium appeared in *The Tea Quarterly*. In this case the stamped mesh was employed in a new type of sifting machine.

A new type of green leaf sifter is undergoing tests.

MANUFACTURE OF LEAF FROM FIELD EXPERIMENTS.

Selection.—Manufacture of leaf from individual bushes selected for high yield continued on the same scale as last year. Every effort has been made to facilitate the selection of quality bushes with good yield records in order that propagation work may not be hindered. However much the war interferes with the other activities of this Department, efforts will be made to keep individual bush manufacture going on the present scale.

Manurial Experiments.—The manufacture of leaf from manurial experiments of the Agricultural Chemistry Department continued on the normal scale.

Acknowledgments.—Our most sincere thanks are due to Mr. R. H. Horne and other members of our team of Colombo Tasters for carrying on the tasting of our experimental samples under difficult circumstances. Mr. Horne who has arranged the meetings has been assisted by Messrs. A. J. Pelly-Fry, H. W. T. Sherwood, M. P. Saunders and J. M. Westwood.

These tasters have no information but a serial number when tasting samples and yet their opinion, as for instance in the case of firing at different temperatures, is consistently the same, month after month when there are consistent experimental differences. The results of the firing experiments are a particularly fine example of the accuracy of their tasting.

Our thanks are also due to Messrs. Forbes & Walker, Whittall & Co., Harrisons & Crosfield, Ltd. and Carson & Co., Ltd. for their assistance in this matter.

The following firms have also assisted us by giving opinion on experimental samples : Messrs. Heath & Co., Colombo Commercial Co. Ltd., Lipton Ltd., Brooke Bond (Ceylon) Ltd.

Apart from arranging team meetings Mr. Horne has also tasted all individual bush samples in connection with our selection work and his careful tasting has resulted in picking out bushes which give consistently good quality.

Once again it is a pleasure to record our appreciation of the advice and help given by Mr. F. J. Whitehead

J. LAMB,
Biochemist,

REPORT

OF

THE SMALL-HOLDINGS OFFICER,

GAMPOLA, FOR 1940.

The work done during the period under review has been in the nature of more concentrated work in smaller areas within the three divisions, namely Uda-Patala, Uda-Nuwara, Yati-Nuwara.

Advisory work that was done in these three divisions was always followed by competitions to create more enthusiasm in the adopting of the new methods advocated.

The results of these competitions always showed there was keenness for better work and, in the adopting of the new methods. As has always happened, the working of these large areas does not however give the opportunity to push forward the temporary keenness shown by small-holders.

There are large numbers of small-holders who are keen on work, who know the value of good work and who would like to be the proud owners of good holdings. But these in turn have their difficulties; such difficulties should be discussed with the owners and every assistance afforded to overcome them—they should not be allowed to get lost in their difficulties and their small-holdings to suffer.

It is for this reason that concentrated work has been started in smaller areas. They have for their guidance those small-holders who took advantage of the first opportunity put before them and improved their holdings on the methods advocated by the T.R.I. Their progress and enhanced assessments during this period of restriction are lessons to others. This concentrated work will help to add to the already large number of improved holdings in the villages.

Restriction.—Looking back on the last few years of work and the very important part restriction has played in the economic problem that faced small-holders, conditions have improved beyond expectations. Coupons

have been made saleable by legislation, which in the opinion and belief of some interested in the Industry has done more harm than good to the small-holdings and tea in general. The saleability of coupons however provided a ready income to those who needed it and one cannot blame owners of tea holdings for selling their export rights, which is legal, to establish themselves once more in the economic world which is only human. This practice did certainly deprive the tea of much of the attention it should have got in the normal course of being kept in bearing, but it has not in this district done the very great deal of harm that is sometimes stated. It is hardly fair to judge all small-holdings on the agricultural conditions existing on those small-holdings on roadsides. I do not think many will believe a statement of this nature. It would be interesting to know the number of appeals lodged by small-holders for increased assessments, the number successful and the opinion of those who assessed these small-holdings, walking at times many miles into the villages.

The small-holder is always out to get the best possible price for his coupons and sales are never made before all inquiries are made.

Advance sales are only made in the case of those in financial difficulties, and they are left with no alternative but to sell at a very reduced rate. They will continue to do this, and no blame can be attached to them, as money-lenders in Ceylon demand such high rates of interest.

The recent legislation on the selling price of tea coupons has made the small-holder's position more secure, doing away with middlemen to a large extent. Restriction which has brought about a forced rest on the tea on small-holdings has done more good than harm. There are now bigger and better bushes on every holding.

Weather.—Weather conditions were not nearly normal and rain not well distributed as in previous years. The first three months saw rather a severe drought. In May we had more rain than was expected. It resulted in floods and the damaging of large extents of cultivated paddy land in this area.

Competition.—The competition brought to a close at the end of June was the second series worked in smaller areas, *i.e.*, Ganga Ihala Korale in Uda-Palata and Meda-Palata Korale in Udu-Nuwara. 124 small-holders entered the competition. These holdings were located throughout the two Korales. The final judging was done by Dr. T. Eden. The distribution of prizes and certificates to the successful candidates was held at the Government Vernacular School at Kirinde. Dr. R. V. Norris very kindly gave away the prizes and certificates.

There were Dr. T. Eden, the Ratamahatmaya of Uda-Palata and a number of small-holders present. This brought to a close a very successful competition from which appreciable benefits were derived by small-holders and added to the large numbers of small-holdings worked on the methods advocated by the T.R.I.

The ready co-operation received throughout my work from the Ratamahatmaya, minor-headmen and village committees has always made my task easy and I offer them my sincere thanks.

The period under review has been one of fair prosperity to small-holders.

R. L. ILLANKOON,
Small-Holdings Officer.

REPORT

OF

THE SMALL-HOLDINGS OFFICER,

BADDEGAMA, FOR 1940.

Lelwela Palata.—As stated in my 1939 report, this Palata was found to be wholly backward agriculturally. Out of 491 small-holders, only 31 were found to be doing any kind of work on their holdings. The majority of the small-holdings were found abandoned.

Small-Holdings Competition.—In spite of the above background, work was persevered with and 15 of the progressive small-holdings were put up for final judging in December. These 15 had made good progress “on all fronts,” to use an apposite war term.

The final judging was done by Dr. T. Eden from 11th to 13th December, and the prize-giving was held in the Wanduramba Government Boys’ School on December 14th, presided over by Dr. T. Eden.

Three cash prizes amounting to Rs. 50-00, and one special mention certificate, were awarded as follows:—

1st Prize. P. M. Thomas (SK. 2845 A1 R2 P0) Pahala Lelwela.

2nd Prize. E. Indigahawela (SK. 2847 A1 R1 P0) Wanduramba.

3rd Prize. H. L. Siyadoris (SK. 1630 A0 R2 P0) Ihala Lelwela.

Commended. K. G. Oraliyas (SKK. 2016 and 2074 A1 R3 P21) Mabotuwewa.

Each of the four villages in the Palata succeeded in winning a prize.

The enthusiastic support of the Wanduramba Village Committee, shown by their second contribution of Rs. 25 for prizes this year, is very encouraging.

A large number of small-holders attended the prize-giving. The presence of visitors from Galle, Dodanduwa, and even Bentota, was a pleasing feature. Their interest in the welfare of the small-holder, and in the activities of the Institute, is very much appreciated.

Each of the small-holders present took away with him a leaflet containing a translation of Dr. Eden's address.

Lelwela Palata should now have well-worked up demonstration holdings, distributed as follows: Mabotuwana and Nathewela—6; Wanduramba—4; Ihala and Pahala Lelwela—5.

The 15 competitors have spent a good deal of their time and money in carrying out progressive works on their holdings. It is hoped they will be successful in their efforts to obtain a better assessment.

Competition Certificate.—A certificate designed for the Southern Province Competition, and signed by the Chairman of the Board of the T.R.I. and the Director, was issued to this year's prize-winners.

The temporary certificates given last year were withdrawn, and these prize-winners also were issued new certificates.

This certificate depicts some important aspects of the advisory work carried out in small-holdings.

I gratefully acknowledge the help given by Mr. N. T. C. M. de Silva, the local Rubber Research Scheme Instructor, in the designing of the certificate.

Rainfall.—90.65 inches were recorded, as against 96.17 inches in 1939.

Work Done.—Visits to small-holdings and small estates, during the year, were as follows: Visits to small-holdings in districts other than the competition area are also included here.

First visits	...	...	178
Revisits	...	...	932
First visits and revisits to estates	...		105
Total—all visits	...	...	<u>1215</u>

On these visits 250 demonstrations were carried out. Mr. W. Amerasinghe of Leo Group, Nathewela, has been extremely helpful in lending his estate labour and tools for these demonstrations.

In addition, during April, 21 of the progressive small-holders from Lelwela Palata were taken to SK. 1989 in Keembiya, one of the 1939 prize-winners, and the importance of the various progressive works effected there explained to them.

Appalling poverty; laziness; innate conservatism; the system of negotiable tea coupons; the anomaly produced by the system of standard assessment: unremunerative green leaf prices; these are some of the

formidable barriers confronting the small-holdings officer. That despite these obstacles, some measure of success has been achieved, is due to the personal interest taken by the Institute's Officers in the welfare of the small-holder even in the remotest hamlets.

Field Equipment.—A mamoty, folk, alavango, pickaxe, and a tape box were bought during the year.

Pruning.—The value of lung-pruning has been stressed. But there have been cases where, in spite of advice, the partiality of the village pruner for clean-pruning has predominated. A tendency to remove lungs prematurely has also been observed.

The pruning in the competition holdings was given close supervision. Each one was given the treatment best suited to it. This resulted in very good recovery with hardly any casualties.

Plucking.—With hardly any demand for the small-holders' green leaf, there was very little plucking, except in some of the competition holdings where it was done carefully.

Supplying.—Good progress was made by the competitors in keeping vacancies filled. In some cases supply holes were filled with earth brought from outside.

Shade and Green Manure Trees.—There has been progress in the use of Albizzia as a high shade. In some cases, as a result of too severe lopping, the trees had failed to come back. Almost all the small-holders, to whom small quantities of seed were issued, obtained good germination results in their nurseries. With these nursery plants they should now be able to bring up a new cover of this useful shade tree.

Gliricidia, as a low shade, was greatly favoured. All the competitors had put in Gliricidia fences, thus increasing the amount of green stuff available for forking in. Replanting was extensively done, and a large number of old badly trained trees cut down altogether.

Special attention was paid to the proper training and lopping of Gliricidia, and good results obtained. A good many of the competitors had even tarred some of the larger wounds caused in the process of training these trees.

The small-holder now realizes the value of these green manure trees. As a result of the advice given, they now know how to get the utmost benefit from them.

A certain amount of success was obtained with *Crotalaria usaramoensis* in contour hedges. SK. 2845, the 1st prize-winner, had some excellent

hedges of this. Careful attention, and use of compost made in the holding itself, had contributed to this result. Contour hedges with *Tephrosia vogelii* were not so successful.

Clitoria cajanifolia.—Contour hedges with *Clitoria* were successfully established in SK. 2105, one of the competitors, with a pound of seed sent by the Principal, Farm School, Peradeniya. Here too the owner showed much keenness in following advice closely, and thus obtained good results. The holding in question was eminently suited for the trial.

Ground Covers.—In June, 5,000 *Indigofera endecaphylla* cuttings, obtained from the Principal, Farm School, Peradeniya, were issued to 25 small-holders. In addition, 15 others were issued cuttings from my nursery, established with some of the cuttings sent from Peradeniya in 1939. In some of the holdings this cover is doing very well.

The co-operation of the Principal, Farm School, Peradeniya, in supplying the *Clitoria* seeds and the *Indigofera* cuttings, free of cost, is greatly appreciated.

Cultivation.—All the competitors had their holdings forked and many manured. Where no manure was used, prunings and green manure loppings were buried.

Fertilisers obtained from estates to whom they were giving their green leaf, dry fish sweepings bought in the Galle bazaar, bonemeal, crushed coconut poonac, and compost made in or near their holdings, were some of the manures used.

Half-a-ton of supply mixture was obtained for TK 50, a small estate.

Composting.—Of the 15 competitors, 8 were induced to make compost on the three-pit system which ensured a regular supply of manure. In every case the pits were cut either in the holding itself or very near it.

One competitor had erected a shed over his compost pits, and made provision for tying his cattle in the shed itself. Another had a portable cadjan cover with which to cover the pits during rain.

In every case the pits were dug out and examined by the judging officer. Wherever necessary helpful advice was given by him.

This knowledge of utilising all waste material, instead of discarding it, should prove very helpful to these small-holders even in the improvement of their other crops.

Drains.—Extensive improvements were carried out in the existing drains. Visits were paid to these holdings during the rains and the

effects of the improvements carried out were investigated. After these inspections further improvements were carried out where necessary. This action resulted in erosion being reduced to a minimum in the competition holdings.

Turf—was extensively used for protecting steep banks above paths, sides of drains, edges of reverse slopes, and edges of compost pits.

Terracing—was extensively carried out with stones and coconut husks. Old stone terraces were repaired and new ones put in where necessary. Every competition holding had its quota of root exposed bushes terraced with stones or coconut husk. In some there were contour terraces wholly made of coconut husks, while in others the edges of reverse slope steps were stone-terraced.

Weeding.—14 of the competitors were persuaded to use the *eetie* for their weeding. Two of them got *eeties* made themselves while the rest bought *eeties* from me at the rate of 26 cts. each. Those of them who had compost pits were induced to collect the weeds and use them for composting.

Other Crops—that were found to be unproductive were cut down in nearly every competition holding. Of the remainder the overhanging branches were cut down.

Estates.—Mr. Silva of Culugahakande Group has been particularly helpful to the small-holders of this Palata by supplying them with *Gliricidia* cuttings. His interest in the small-holders is praiseworthy.

The public-spiritedness of the proprietors of Leo Group and Lavalhena Group in putting up well-worked up small-holdings for the competition deserves mention. They have thereby rendered the small-holders of this area a distinct service.

Pests and Diseases.—One case of Shot-hole Borer, and 3 cases of Red Coffee Borer, were observed, and necessary advice given.

Meetings.—7 meetings of small-holders were held in the following areas: Bentota-Walallawiti Korale, Talpe Pattu, Four Gravets (Galle), and Tebuwana.

The Tebuwana meeting was arranged by Mr. D. M. Athulathmudali of Warakagode. His interest in the welfare of the small-holders of that area is commendable.

Five of the other meetings were arranged by the Mudaliyar of Bentota-Walallawiti Korale, Talpe Pattu, and Four Gravets (Galle). The remaining one was arranged by the Village Headman of Hiyare in Talpe Pattu.

The co-operation of these chief and minor headmen, and their interest in the small-holders and activities of the Institute, are very encouraging. Their help is gratefully acknowledged.

At these meetings helpful addresses were given. Each of the small-holders present was given a folder, containing a translation of the Director's speech made on 9-12-1939, to take away with him.

Leaflets.—In addition to 232 copies issued at the above meetings, this folder has been sent by post to the following, in the tea-growing areas: chief headmen, tea owning village headmen, chairmen of village committees, and co-operative societies. Small-holders in those areas where there has been an extension of advisory work, have also been given copies. The contents of this leaflet have been referred to in my 1939 annual report.

Special Visits—to Warakagoda in the Tebuwana area during May, to address a meeting of small-holders, and to Horana in October, to attend the prize-giving in connection with the Rubber Research Scheme small-holdings competition.

Appeals.—10 small-holders were found to have been successful in their applications for re-assessment.

New Working Area.—The Kottawa and Walawe Palatas in Talpe Pattu are being taken up for intensive work in 1941. The new area borders on the 1939 and 1940 working areas.

Preliminary visits to two villages have been completed. It is apparent this area needs a good deal of attention.

The Kottawa Village Committee has unanimously voted Rs. 25 for a small-holdings competition for these two Palatas, and arrangements are being made to initiate one early in the new year. The Committee is thanked for their co-operation.

Floods.—There were abnormal floods during May and some tea small-holdings were badly affected. The provisions of Section 28 of Ordinance No. 12 of 1938 were explained to those owners who sought advice.

The War.—A sum of Rs. 122 collected for the War Purposes Fund from the working area was remitted to the A.G., S.P., through the Pattu Mudaliyar.

Those small-holders in the interior who were anxious to know about the progress of the war were given the latest news.

Gangabodde Pattu.—I wish to place on record the generous help given by Mudaliyar V. E. de Saram of this Pattu, his headmen, and office staff.

Mudaliyar De Saram has taken a personal interest in the activities of the Institute in his area. This interest he has infused into headmen also.

Mr. Pandithesekera, the Chief Clerk of the office, has given unstinted help with simple and lucid translations of the various leaflets issued in connection with competitions organised in this Pattu.

To the Mudaliyar and the others I tender my grateful thanks.

General.—A small-holder succeeded in his application for the post of Village Headman, Central Keembiya.

Office.—21 small-holders visited the office and obtained necessary advice. One of them came all the way from the Kalutara District.

196 letters were received and 597 letters sent out.

A photographic record of interesting work carried out in small-holdings is kept.

Quarters.—No change.

In closing I wish to thank the following also for their co-operation and help: The Chairman and Members of the Wandurambe Village Committee; the Mudaliyars of Gravets (Galle); Talpe Pattu; Bentota-Walalla-witi Korale; and their Headmen; The Principal, Farm School, Peradeniya, the Superintendent of Culugahakanda Group; Mr. N. T. C. M. de Silva of Poddala; and Mr. D. M. Athulathmudali of Warakagode.

F. D. TILLEKERATNE.

Small-holdings Officer.

The Tea Research Institute of Ceylon.

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